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The Institute of British Foundrymen
The Institute of Vitreous Enamellers
The National Ironfounding Employers' Federation
The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

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The Sheffield Conference

The 32nd Annual Conference of the Institute of British Foundrymen was held during last week in Sheffield under the chairmanship of Mr. J. E. Hurst, a metallurgist of international reputation on account of his pioneer work in the development of the centrifugal-castings process and his many published scientific Papers and books. The Conference was an outstanding success and, as a measure of its size, perhaps the most reliable figure is that of the number of covers laid for the annual banquet—three hundred and ninety-five. The recently-introduced system of holding the annual general meeting on the Tuesday evening of the Conference, proved its utility as a real time saver for the technical session. This was specially necessary because, in addition to the usual civic and other formal welcomes, time had to be found for the inclusion of a new feature—the Edward Williams Lecture. Sir William Larke, who undertook this task with conspicuous success, has indeed set a high level for those who will follow him year by year.

Sir William Larke took his audience from Neolithic times to the current year, and fascinated them by his clever correlation of metallurgical discovery with the material development of the human race. The distinguished lecturer made clear to his listeners the immensity of the field of metallurgy and the smallness of the plot in which each of us as individuals ploughed our mean little furrow. "Man and Metals" made a striking contrast with the presidential address, which was a critical study of the fundamentals of the heat-treatment of cast iron, as in the latter case Mr. Hurst showed how by amassing new data in our small corner of the field of metallurgy a new vista was opened capable of having important repercussions over an immense area. His reference to the pioneer scientific work of Professor Turner, who, happily, was present at the Conference, was as interesting as it was courteous and appropriate.

The Papers submitted for discussion indeed attained a high level, and whilst it is invidious to single out any one as being specially meritorious, no one will cavil if we mention the names of Dr. T. Swinden and Mr. Bolsover, as being a concrete example of the desire of the steel trade to co-operate with the foundry industry for their mutual welfare. Unfortunately, there was no time left to discuss the extremely able Papers dealing with steel castings. This is often somewhat distressing to the authors, and we sincerely hope that members will send along contributions in writing. Whilst a "forced" discussion usually results in the passing of empty compliments by eminent people, yet we cannot help thinking that quite often too little time is allowed for reasoned criticism.

The receptions by the Civic and University authorities were highly appreciated, whilst the annual banquet and dance were an outstanding success. The quips of "Stainless Stephen"—the reincarnation of the court jester—were much appreciated by visitor and host alike. The whole organisation of the Conference was extremely successful, and the appreciation of the work of Mr. T. R. Walker was marked by a presentation of a unique collection of old Sheffield plate. Obviously, such an extensive organisation is a co-operative affair, and the visitors were assured that Mr. Arthur Whiteley, the local Branch-President, had also devoted an enormous amount of energy to its preparation. A really great effort was made by the Sheffield Branch, and the help given by the authorities—Civic and University—and the large industrial establishments was such as to convince the visitors that the foundry industry was recognised as worthy of their most lavish hospitality. We can assure them that more appreciative guests have never been entertained, and that Sheffield will even more have real recognition as one of the most hospitable towns in England.

Parallel Sessions

As a minor footnote to the congratulations to those organising the Sheffield Conference, the position of Conference Papers and their consideration in parallel sessions is worth consideration. Although the number of Papers to I.B.F. Conferences is usually not large, their discussion demands more time than can be allotted in the sessions available. This year the adoption of the practice of taking the Papers really as read (for which purpose, of course, they are preprinted) improved the time available for discussion very materially. Even so, the necessity for running Papers in sessions held in parallel arises, and this involves various disadvantages. While there are, as a rule, enough Papers on cast iron (and in the case of this year, steel) to make a coherent group having some sort of relationship to each other, the other session tends to group the remainder, diverse in character, and hence attracting a shifting audience. The trouble occurs when some members want to attend Papers in both sessions at the same time. This was felt so much that, in fact, the Paper on ingot moulds was given to both sections and well discussed, with the result that a very inadequate time was left for all the other Papers. This was particularly unfortunate in the case of the lengthy and very practical Paper by Mr. Machin and Mr. Oldham. One of the best Papers of its kind the Institute has ever had, or is likely to have, and of a type appealing to the large number of practical men present, its dis-

(*Concluded on page* 22.)

XUM

X-Ray Analysis

APPLICATIONS TO INDUSTRIAL PROBLEMS

We append details relating to the application of X-ray analysis to industrial problems, taken from the Annual Report of the National Physical Laboratory for 1934,* recently published by the Department of Scientific and Industrial Research.

The work carried out under the auspices of the Committee on the Application of X-ray Methods to Industrial Research has been continued along the following lines.

Magnet Steels

In previous Reports it has been shown that the presence of a large amount of internal strain is in general a characteristic feature of the structure of a high-grade magnet steel, and that processes, such as suitable heat-treatment, which tend to remove such strain, result in a lowering of the magnetic quality. X-ray studies of the effect of heat-treatment on materials such as tungsten and cobalt steels have indicated that the carbon in such steels plays an important part in the production of the internal strain, which is measured by the broadening of the diffraction lines. Arrangements have been made for a more detailed study of the effect of variations in the chemical constitution on the maximum amount of strain which can be introduced in the crystal lattice and the corresponding changes in the magnetic properties of the steel. In special permanent-magnet materials such as nickel-aluminium steels, where no carbon is present, other factors appear to influence the magnetic quality. Preliminary X-ray investigations of such steels show that the structure characteristic of magnetic material with high-coercive force and remanence is one in which the nickel and aluminium atoms do not replace the iron atoms in a random manner, but in a regular way, so as to produce a type of super-lattice structure.

Transformer Steels

X-ray work on steels used as cores for electrical transformers has proved that satisfactory material is characterised by a structure in which the individual crystallites are free from internal strain. The annealing treatment which results in the removal of strain leads in general to a growth in the size of the crystallites, but this growth is not necessarily a good feature, since it may tend to an increase in eddy-current losses. Further work has confirmed these results. Thus X-ray work on nickel-iron alloys of high initial permeability has shown that the best material has a structure in which the crystals, although relatively small, give X-ray reflections corresponding to a high order of perfection. It is believed that silicon steels can be obtained with better magnetic properties if their component crystallites are kept relatively small and as perfect as possible. Work with this end in view is in progress.

Crystal Lattice Distortion and Physical Properties

In investigations already carried out at the Laboratory, it has been shown that in most metals cold-work processes result in a broadening of the X-ray diffraction lines, which has been interpreted as evidence for the existence of strain and distortion in the crystal lattice. Measurements of the amount of the broadening give an estimate of the amount of this internal strain, and it has been shown that the electrical, magnetic and tensile properties of the metal vary with the state of perfection of the crystals measured in this way. In extension of this work, detailed studies have been made of the effect of cold rolling on the structure of alpha-brass. Measurements have been made of the changes in breadth of the diffraction lines, and these have been compared with the results of hardness measurements. Quantitative measurements from photographs indicate that there is a smooth relation between the increase in hardness and the breadth increase. The lines do not broaden symmetrically about the position of the undistorted line, but the greater part of the broadening occurs on that side of the line which would indicate an increase in the size of the unit crystal cube. It would appear from this work that the strain-hardening results from the distortion of the crystal lattice, and that the breadth of the X-ray diffraction lines can be used as a measure of the strain-hardening effect.

Further studies have been made on the changes in the X-ray diffraction patterns of wires before and after they have been stretched by progressive loading. Wires of copper, nickel, alpha-brass and Constantan have been examined. In each case similar effects were found. As the load on the wire is increased the diffraction lines broaden; the broadening, small in the early stages, grows rapidly in the neighbourhood of the yield point, and continues this relatively-rapid rate of increase until fracture occurs. Measurements of the breadth of the lines at the point corresponding to fracture show that it is of the same order of magnitude as the maximum breadth observed in experiments with other methods of cold work, such as rolling or drawing. The results lead to a method of estimating the degree of lattice distortion, and therefore of internal strain, present in a given metal specimen, and of comparing the result with the further amount of distortion which may be imposed before a saturation point is reached.

* H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2. Price 13s. net.

New British Chemical Standard for Alloy Irons

The British Chemical Standards, 3, Wilson Street, Middlesbrough, have issued the first of a series of standard irons containing special elements.

This standard analysed sample is more or less typical of the type used for the production of specially hard cast irons by alloying and heat-treatment, and should be useful to chemists wishing for more information about the determination of Ni, Cr, and Mo, and the effect of these elements on the determination of the ordinary constituents. The standard turnings have been carefully analysed, as usual, by a number of experienced chemists representing the different interests involved, viz., the B.C.I.R.A., independent analysts, a government department, a ferro-alloy manufacturer and producers and users of alloy cast irons. The constituents standardised are as follow:—Total Carbon 2.79, Graphitic Carbon 1.99, Combined Carbon 0.80, Silicon 1.64, Manganese 0.93, Sulphur 0.068, Phosphorus 0.348, Nickel 1.71, Chromium 0.405, Molybdenum 0.36 per cent.

It is believed that this is the only standard of its kind in Great Britain and is therefore likely to be of national interest to both independent chemists, government chemists and works chemists associated with the manufacture and use of alloy irons, including the aviation, motor and engineering industries.

The standard is issued in bottles containing 500 grms., 100 grms., 50 grms. and 25 grms. at a price which it is estimated will eventually cover the cost. Each bottle is provided with a certificate showing the analysis of each chemist, together with an outline of the methods used; in particular the method for determining molybdenum has been deal with at some length and will no doubt be of interest. The standard may be obtained from British Chemical Standards (Ridsdale & Company), 3, Wilson Street, Middlesbrough, or the usual laboratory furnishers.

Institute Elects New Members

At the Council Meeting of the Institute of British Foundrymen held at Sheffield on Tuesday, July 2, 1935, the following were elected to various grades of membership:—

As Members.

G. B. Allwood, Commercial Representative, T. W. Ward, Limited, Sheffield; W. E. Benbow, Metallurgist, Editor, "Iron and Steel Industry," London, W.C.2; Wilhelm Büsselman, Foundry Engineer, Tynemouth, Northumberland; Wm. Hamilton, Salesman, General Refractories, Limited, Sheffield; T. C. Hobson, Foundry Manager, Stanton Ironworks, Limited, near Nottingham; H. Jeans, Director, Wolverhampton Steel & Iron Company, Limited; E. C. Marsland, Works Manager, Qualcast, Limited, Derby; R. T. Percival, Lecturer in Foundry Metallurgy, University of Sheffield; J. Shauer, Chemical Engineer, Central Institute of Technical and Economic Information, Moscow, 64, Semlanoy Val 47; T. H. Taft, Foundry Manager, Idoson Motor Cylinder Company, Smethwick; D. A. S. Williams, Manager, Rotary Furnace Department, Stein & Atkinson, Limited, 47 Victoria Street, London, S.W.1; G. L. Harbach, Metallurgist, Worthington-Simpson, Limited, Newark.

Associate Members.

N. Charlton, Metallurgical Chemist, C. A. Parsons & Company, Limited, Walkergate Works, Newcastle-upon-Tyne; J. Dearden, B.Sc., A.M.I.Mech.E., Works Metallurgist, L.M.S. Railway, St. Rollox, Glasgow; J. R. Downing, Foreman Patternmaker, Armstrong, Whitworth (Ironfounders), Limited, Gateshead; J. E. Fraser, Foundry Foreman, Armstrong, Whitworth (Ironfounders), Limited, Gateshead; A. H. Hardman, Foundry Foreman, Armstrong, Whitworth (Ironfounders), Limited, Gateshead; J. Merrick, Patternmaker, Singer Manufacturing Company, Limited, Clydebank; J. J. Raval, Mechanical Engineer, Sheth Jagannath Nasayan Gumming and Pressing Factory, Ramganjmandi; Henry Scott, Foundry Foreman, Armstrong, Whitworth (Ironfounders), Limited, Gateshead; A. T. Timms, Foreman Moulder, Vickers-Armstrong, Limited, Elswick Works, Newcastle-upon-Tyne.

Associate.

O. L. Pollack, Engineering Apprentice, Austin Motor Company, Limited, Longridge, Birmingham.

Parallel Sessions

(*Concluded from page* 21.)

cussion had to be relegated to the end of the symposium on steel casting, with which it was only partially concerned, while another session considered the also very practical Paper from France.

We do not pretend to have a cut-and-dried solution to this problem, except to suggest that those who have to preside at a meeting should not feel nervous if the discussion on a Paper unexpectedly fails or falls flat. A very strict time-schedule could then be arranged and adhered to, so that each Paper secured its fair share of attention. This would be convenient for those who wish to attend selected Papers, because it is no use pretending that everybody is equally interested in everything. We are also afraid that in many cases contributions to discussions (to secure which is the whole reason for having the meeting) are seldom sent in writing if they are not given at the meeting for lack of time. The ordinary press of business is apt to intervene between the intention and the accomplishment. A fair allocation of time (not necessarily the same for all Papers) and ruthlessness on the part of the chairman, equipped with traffic lights and guillotine, seem to be indicated.

INSTITUTE OF BRITISH FOUNDRYMEN

THIRTY-SECOND ANNUAL CONFERENCE AT SHEFFIELD

Wednesday, July 3

The first session of the Conference proper opened on Wednesday morning, July 3, in the Mappin Hall of the University, St. George's Square. The retiring President (Mr. Roy Stubbs) presided during the early part of the proceedings.

Civic Reception

The Lord Mayor of Sheffield (Alderman P. J. M. Turner), the Master Cutler (Mr. A. Williamson), the President of the Sheffield Chamber of Commerce (Mr. A. K. Wilson) and other representatives of the civic, industrial and academic life of Sheffield were present to welcome the delegates. Apologies for their inability to attend were received from the Vice-Chancellor of the University (Dr A. W. Pickard-Cambridge), the Lord Bishop of Sheffield and the Provost and Archdeacon of Sheffield (the Very Rev. A. C. E. Jarvis, C.B., C.M.G., M.C., D.D., Chaplain to the King).

The LORD MAYOR said that he regarded it as a privilege as well as a pleasure to be able to offer the members of the Institute and their guests a most cordial and sincere welcome to the great industrial city of Sheffield on the occasion of the Institute's thirty-second Annual Conference. Thanks to the progressive outlook of the City's local government, he said, Sheffield was rapidly becoming one of the Conference centres of the country. The meeting was being held in the Mappin Hall, which was part of the University buildings, and it was a pleasing feature of the developments of the city life that there existed the very closest co-operation between the leaders of industry and the leaders of this great centre of learning. The relations which continued to exist between the University and the leaders of industry in Sheffield had in his judgment done much to stimulate the industrial recovery during the past two or three years, and as he rejoiced at the signs of improved trade and prosperity in the City, he realised that foundrymen had taken no small part in it. When the Institute had last held a Conference in Sheffield, eight years ago, the City was beginning to feel the strain of the drift towards unemployment, and during those eight years which had intervened the City had passed through a very trying period. But with loyal co-operation, everybody concerned—leaders of industry, workmen, the administrators of the City's affairs, and those who were working in connection with the University—had faced up to these problems, and they could all rejoice at that moment in the fact that they could see the turning of the tide so far as industry was concerned. During the last three or four years Sheffield had been spending more than a million pounds per annum on the maintenance of the unemployed, and that had imposed a serious burden upon the City. Not only the householder and the ratepayer, but also industry had felt the burden; but to him it was a matter for great relief and for rejoicing that during his year of office, at all events, a great step forward had been taken in regard to trade recovery in Sheffield and the country as a whole. He ventured to suggest that the part which Sheffield had played in this recovery would become more manifest as time passed. The steel industry had done much to bring about this very splendid result.

Finally, the Lord Mayor expressed the hope that the Conference would prove to be to the Institute one of profit and pleasure, and that when those who attended returned to their homes they would have none but the pleasantest recollections of the week they had spent together in that great metropolis of the steel industry. On behalf of the citizens, he extended to them the most cordial welcome.

Presentation of Meritorious Service Medal

The LORD MAYOR then presented to Mr. H. Bunting (hon. secretary of the East Midlands Branch of the Institute) the Meritorious Service Medal in recognition of his past services.

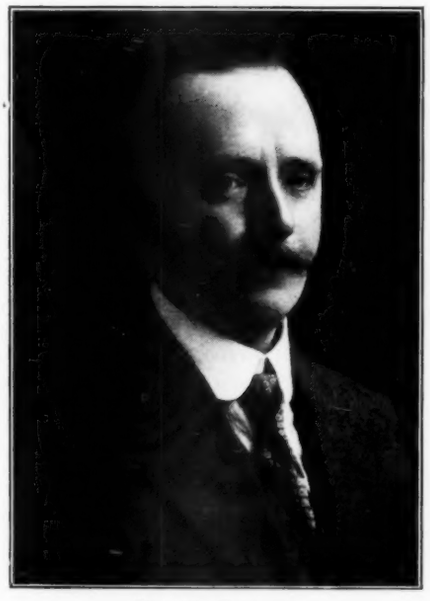
The GENERAL SECRETARY OF THE INSTITUTE (Mr. T. Makemson) explained that the Meritorious Service Medal was instituted two or three years ago, to be awarded, not necessarily every year, to a member of the Institute who had performed particularly meritorious service over a long period. It was not to be awarded necessarily for spectacular service or in respect of some spectacular event, but it was hoped to award it from time to time to members who had carried out a good deal of work which, although much of it was unseen, was nevertheless of the utmost value on the administrative side of the Institute's affairs. This year the Council had decided to make the award to Mr. Bunting, and felt that in so doing they were fulfilling the intention, because Mr. Bunting had carried out the very onerous duties of hon. secretary of the East Midlands Branch for no less than 20 years. No other Branch-Secretary had ever been able to withstand 20 years' service! During that time Mr. Bunting had been largely responsible for bringing his Branch to the very forefront in efficiency, in prestige, and in membership. Such work was not usually done in the limelight; in making the award the Council felt that they were bestowing it very worthily and that in honouring Mr. Bunting they were honouring themselves.

MR. H. BUNTING, expressing his pride in having been awarded the medal, assured the members that his twenty years of secretaryship had been very happy years, and there was nothing connected with the work during that time with regard to which he had any regrets. Although he had advised his successor not to keep the job for twenty years, he could assure his many friends in the Branch that it had been a difficult matter for him to part with the Branch books; the experience was like parting with a friend. However, he felt sure that there were many who would have been glad to have performed such services or any other services, and that they would have done so as well as, or probably far better than, he had. If the members of the East Midlands Branch were to mention his many shortcomings, the members of other Branches would be astounded. But his friends in the Branch had been very patient. He was indebted for the very kind things Mr. Makemson had said concerning his abilities, and to which the Lord Mayor had also given support, because his wife was present, and she never would believe before that he had so many good points! He hoped that in the future, if he attempted to become a little slack, the medal would remind him of his obligations, and would restore him to activity, not only on behalf of the East Midlands Branch, but also of the Institute as a whole.

The MASTER CUTLER (Mr. A. Williamson) extended a welcome to the Conference, on behalf of the Cutlers' Company, which was one of the most ancient companies in the country. The Cutlers' Company, in conjunction with the manufacturers of Sheffield, including both the heavy and the light branches of the industry, were always pleased to receive visitors, such as the members of the Institute, and to show what was being done in Sheffield, and how and why it was done. Those who had attended the previous Conference of the Institute, held in Sheffield eight years ago, would be astonished, when they visited the various works, by the advances which had been made during that period of eight years. They would have the opportunity of seeing modernised plant such as was not in contemplation when they were last in Sheffield; they would see smiling faces in most of the works, whereas perhaps eight years ago they had seen very long faces.

Sheffield had become a hive of industry, and he was pleased to see his very good friend, Sir William Larke, and to know that he was going to lecture, because Sir William always gave his audiences something well worth thinking about. Sheffield had to thank Sir William for the strenuous work he had put in on behalf of the steel industry within the last few years. He had had almost as much as anyone to do with the recovery in Sheffield. One was reminded, for instance, of his efforts to secure the adoption

MERITORIOUS SERVICE MEDAL AWARD



MR. H. BUNTING.

MR. H. BUNTING, to whom a Meritorious Service Medal has been awarded in recognition of his twenty years' service as secretary of the East Midlands Branch, is foundry manager of the Rutland Foundry Company, Limited, of Ilkeston. Mr. Bunting started his career with Ley's Malleable Casting Company, Limited, Derby, and was appointed to his present position after experience with the Phœnix Foundry Company, Derby, the Rutland Foundry, Ilkeston, and the Haslam Foundry, Derby. He studied chemistry and metallurgy at the Technical College, Derby. His association with the Institute began in 1910, when he joined what was then known as the British Foundrymen's Association. On the formation of the East Midlands Branch of the Institute he was appointed secretary, from which office he has just resigned after twenty years' service. Mr. Bunting has taken an active interest in the training of young foundrymen, both as demonstrator and lecturer on foundry practice at Loughborough College, and as lecturer on foundry subjects at University College, Nottingham, and at the Technical College, Derby. He has been very successful with students taking the City and Guilds of London Institute Examination.

of tariffs, and of his work in connection with the arrangements which had been made with the steel cartel on the Continent. The combination of these two things alone had been, and would continue to be, of inestimable value to Sheffield and district, and it was due largely to the tariff position that Sheffield was able to show many of the activities which the visitors would see during the week. Last year the output of steel from Sheffield had constituted a record, for it was far greater even than during the war; it had amounted to 1,300,000 tons of steel last year. That had been made possible largely by the work carried out during the cleansing period, *i.e.*, during the years of depression. The people had not much work to do then, and had had plenty of time to think, and that time had been spent very usefully. The plant available was much more scientific and more efficient than that used previously, and production in that area had become much more economic than ever before in the history of Sheffield.

It afforded him the greatest pleasure, on behalf of the Cutlers' Company and the manufacturers of Sheffield generally, to welcome the Institute, and he hoped that all members would benefit from the Conference, both in mind and body.

The PRESIDENT OF THE SHEFFIELD CHAMBER OF COMMERCE (Mr. A. K. Wilson), who extended a hearty welcome on behalf of the Chamber of Commerce, said that founding was a very important branch of the Sheffield trade, and he believed all the Sheffield members of the Institute were members of the Chamber. Sheffield was proud of the prominent part which it had always played in the development of founding, and he was glad to feel that the foundry industry was benefiting, as were other industries, by the improvement in trade. He hoped that the visit of the members to Sheffield would prove to be interesting, and that they and the City of Sheffield would derive mutual benefit from it.

Vote of Thanks

The retiring PRESIDENT proposed a hearty vote of thanks to the Lord Mayor, the Master Cutler and the President of the Chamber of Commerce, and said the members appreciated very much the fact that, in spite of the many calls upon their time, they had found it possible to attend the opening of the Conference. He also took the opportunity to thank the Lord Mayor and Lady Mayoress for their very kind reception of the members at the Town Hall on the previous evening, and said it was gratifying that the Lord Mayor and the Municipality of the City appreciated that the Institute was worthy of a civic reception.

MR. J. E. HURST (President-Elect), seconding, said he hoped it was realised that the welcome accorded them in Sheffield was unique, for in no other city in Great Britain could they have been welcomed by a Master Cutler as well as by the Lord Mayor and President of the Chamber of Commerce. As President of the Sheffield Branch, Mr. Hurst took the opportunity to express, both on behalf of the Branch and the Organising Committee of the Conference, the heartiest thanks to the Lord Mayor and Lady Mayoress for their hospitality on the previous evening, which all members had greatly enjoyed.

The LORD MAYOR briefly responded, and said that the Lady Mayoress and himself had indeed welcomed the opportunity of social intercourse with them, and so to widen the circle of friendships which he hoped was being formed during his year of office. The opportunity to meet people from all parts of the country was a very pleasant feature of the Lord Mayoralty; he trusted that all the friendships which were being formed would be of mutual advantage, and that the reception on Tuesday evening would mark the beginning of a very valuable Conference. The Lord Mayor, the Master Cutler and President of the Chamber of Commerce then withdrew.

Induction of New President

MR. STUBBS then formally invested Mr. Hurst with the Presidential Badge and Miniature and installed him as the Institute's thirty-second President. In offering Mr. Hurst his heartiest congratulations and best wishes for a successful year, Mr. Stubbs jocularly congratulated himself on being once again a free man.

Presentation of Badges

MR. HURST having formally occupied the chair, amid prolonged applause, his first duty was to present the Past-President's badge to Mr. Stubbs, whom he hoped would continue his active association with the Institute and continue to give it the benefit of his advice.

MR. STUBBS assured the meeting that he would be happy to render service to the Institute.

MRS. STUBBS then presented to Mrs. Hurst the collarette and badge which is worn by the President's wife. She wished Mrs. Hurst the best of luck, and hoped that she would get as much enjoyment from the work as she herself had done during the past year. Mrs. Stubbs also took the opportunity to express her gratitude for the kindness which had been extended to her personally during the past year.

MRS. HURST, amid applause, expressed her pleasure in receiving the collarette and her appreciation of the honour it carried with it.

The PRESIDENT took the opportunity to propose a vote of thanks to Mrs. Stubbs for her very able assistance to the President during the previous year.

The President then invested Mr. H. Winterton with the collarette of the Senior Vice-President.

Mr. C. W. Bigg (Junior Vice-President) was also accorded a hearty welcome in his new office.

Members of Council

The result of the ballot for the election of Members of Council was announced as follows:—*Elected for two years:* Prof. J. H. Andrew, Mr. V. Delport, Mr. E. Longden, Mr. P. A. Russell, Mr. D. H. Wood. *Elected for one year:* Mr. R. A. Miles (in succession to Mr. E. Stevenson, who has resigned).

Greetings from Overseas

The General Secretary announced the receipt of the following messages:—

From the FRENCH FOUNDRY ASSOCIATION:—

"Association Technique de Fonderie de France send cordial salutations to their British colleagues and best wishes for the success of the Conference.—RAMAS, President."

From the BELGIAN FOUNDRYMEN'S ASSOCIATION:—

"Hearty congratulations to President Hurst. Please transmit to the delegates the cordial salutations of the Belgian founders. We invite our British friends to assist in large numbers in the International Congress at Brussels.—LÉONARD, President."

From the AMERICAN FOUNDRYMEN'S ASSOCIATION:—

"Greetings and felicitations from officers and members of the American Foundrymen's Association to thirty-second Annual Conference of the Institute of British Foundrymen.—HEINEBACH, Chairman of the Committee on International Relations, American Foundrymen's Association."

From the TECHNICAL HIGH SCHOOL, Aachen:—

"Greetings and good wishes for a successful Conference.—PIWOWARSKY and NIPPER, Technical High School, Aachen."

From DR. VANZETTI (Milan):—

"Impossible to be present at Conference. Best wishes for its success.—GUIDO VANZETTI."

From DR. GEILENKIRCHEN (President, German Foundrymen's Association):—

"On the occasion of your annual general meeting we send you our heartiest wishes, and we hope that your deliberations will be crowned with success.—MAIN TECHNICAL COMMITTEE FOR FOUNDRY PRACTICE."

The meeting instructed the General Secretary to reply to these messages of goodwill.

Welcome to Foreign Delegates

The meeting accorded a hearty welcome to Mr. W. A. Geisler, representing the German Foundrymen's Association, and who is a member of the Institute; and to Dr. Loeb, of the Molybdenum Company of America.

Mr. Hurst then delivered his Address.

PRESIDENTIAL ADDRESS

Mr. Stubbs and Gentlemen,—"*The renewed and extended interest in cast iron came as a surprise to those who believed the days of the ironfounder to be numbered, and was a revival which was as unexpected as it was pronounced.*"

(Professor Thomas Turner, Birmingham Conference of the British Foundrymen's Association, August, 1909. Address entitled "Twenty-Five Years of Cast Iron.")

This paragraph in Prof. Turner's address over 25 years ago will serve to concentrate our attention on conditions as they exist to-day.

The remarkable developments which have taken place in the metallurgy of cast iron during recent years have been accompanied once again by a revival of interest, exactly as 25 years ago. It is not possible for me to deal comprehensively with all the developments which have accrued for the most part during the last ten years, but in selecting just one section of the metallurgy of cast iron, I have chosen that of its heat-treatment. I have chosen this because, in the first place it is a development which is as unexpected as it is pronounced, and in the second place it is a development which may be truly said to have originated in many of its directions in the Sheffield district. If I may add a third reason, it would be that I feel that the importance of heat-treatment of cast iron is only just beginning to be realised, and I am of the opinion that with further research and progress, the facility to heat-treat cast irons will play a vital part in maintaining and extending the industrial development of cast iron.

Heat-Treatment of Cast Iron

It is probably true to say that the heat-treatment of grey cast iron in various manners has been practised for a long time, but it is equally true to say that it was practised more or less surreptitiously. Engineers have looked upon it with disfavour and leading metallurgists in the past have categorically stated that by exposure to high temperatures cast iron is ruined. To-day, the position is completely changed, and metallurgists are able to show equally as emphatically that by exposure to high temperatures, as in correct heat-treatment, cast iron is not ruined, but actually its properties are considerably improved. The practice of heat-treatment in various forms has become firmly established and a substantial tonnage of cast-iron castings are heat-treated commercially and accepted by engineers without any qualms or misgivings as to inferiority in mechanical properties.

This change in view, in so far as hardening and tempering cast iron is concerned, has been brought about largely by the pioneer investigations of firms in the Sheffield district. Systematic experiments revealed the fact that cast iron could be hardened by quenching in water or oil from suitable temperatures. In this hardening condition, cast iron, when reheated or tempered at various temperatures, is softened to a varying extent according to the reheating temperature chosen exactly as in the tempering of steels. The exploration of the change in mechanical properties during such hardening and tempering treatments has now been carried out on a great variety of cast irons and alloy cast irons by a great many investigators throughout the world, and it has been clearly established that in the hardened condition prior to tempering a high degree of hardness is obtained, but is accompanied by mechanical weakness and a general lowering of the strength properties. The subsequent tempering treat-

ment, however, has the remarkable influence of restoring the mechanical properties accompanied by a steady falling off in the hardness and a recovery of the machinability. Almost without exception it is found that tempering at a certain temperature yields mechanical-strength properties very substantially greater than the material in its orginal "as-cast" condition, and from diagrams showing the relation between the properties in the "as-cast" hardened and tempered condition it will be seen that the tempering temperature/strength curves follows a course passing through a maximum at which the strength is higher than the original "as-cast" material. This critical tempering temperature varies probably with the particular composition and properties of the cast iron, but it is clearly indicated in all the numerous experimental results now available.

As would be expected, investigators have paid very great attention to the effect of such treatments on the brittleness, and this attribute of the mechanical-strength properties has been studied by utilising a variety of impact tests and also by the study of the resilience and the type and characteristics of the stress-strain curves. Here again it has been established that these properties in relation to the tempering temperature follow a similar course to the ultimate strength curve, and that with the correct heat-treatment the brittleness, rather than being increased, is actually diminished, and a degree of toughness substantially in excess of the original "as-cast" condition can be obtained. For example, this property has been studied for cast irons of varying phosphorus content, a constituent which is known to have an intrinsic effect on the brittleness of cast iron. It is found that the same rule holds, and even up to high percentages of phosphorus such as occur in some of our industrial cast irons, the strength properties, including the resistance to brittleness, are raised by suitable hardening and tempering treatment.

Alloy Additions

The discovery of the rational response of cast iron to hardening and tempering treatment has led to the study of the influence of alloy additions in respect to this treatment. Alloying elements, such as nickel, chromium, copper, molybdenum and others, have been carefully studied. As in the case of alloy steels, the influence of these elements on the critical speed of cooling can be utilised for similar purposes, such as increasing the depth of penetration of the hardening effect, and nickel-chromium alloy cast irons suitable for air hardening are already in commercial use. The effect of these alloy additions on the capacity of cast irons for heat-treatment has already been of major importance in the economic justification of these additions to cast iron, as in the case of steels. An example of interest, and possibly of general importance, will not be found out of place.

In some experimental work in connection with a rather complex alloy cast iron containing aluminium, chromium and nickel, after exposure to temperature conditions in the neighbourhood of 500 deg. C. changes in mechanical properties were disclosed, which took the form of a marked falling off in tensile strength and resilience value. On the assumption of an apparent analogy between these phenomena and those of temper brittleness in steels, the effects of additions of molybdenum have been investigated, and quite a number of experiments show clearly that molybdenum, either alone or in conjunction with aluminium, does not bring about any reduction in strength after low-temperature treatment at 500 deg. C. under nitrogen-hardening conditions, and that it is also effective in preventing the reduction in strength under these conditions when nickel is present in the alloy. A few results are given in tabular form in illustration of this. It is, of course, possible that this aspect of the influence of molybdenum is of importance in other considerations of this element in cast iron.

The microstructure of cast iron in the quenched condition is martensitic. As in the case of steels the structures on tempering pass through the troostite sorbite stages to pearlite. There is, however, an important difference between cast irons and steels in the part played by the graphite, and it is certain that the whole of the hardening effect is not brought about by the pearlite or that the initial presence of pearlite is necessary to ensure hardening. Recent experimental work shows that the results obtained by heat-treatment are influenced also to an extraordinary extent by the form in which the graphite exists. For example, the hardening and tempering of cast irons having the ferrite/fine graphite structure has been accompanied by increases in strength of well over 100 per cent. in comparison with the untreated condition. The following experimental details are of interest in showing the effect of the amount and form in which the graphite exists.

These two specimens, prepared in exactly the same manner and differing only in phosphorus and combined carbon contents, showed a marked structural difference. Specimen 1 had an almost complete ferrite-fine graphite structure, and the fracture showed the characteristic appearance,

Spec. No.	T.C. Per cent.	Gr. Per cent.	C.C. Per cent.	Si. Per cent.	Mn. Per cent.	Ph. Per cent.
1	3.45	3.45	Nil	2.25	0.65	0.032
2	3.47	2.99	0.48	2.50	0.60	0.52

Moduli of as cast.	Rupture. Tons per sq. in.		Brinell. 2 mm. 30 kg.		
	H. & T. 275 deg. C.	H. & T. 450 deg. C.	As cast.	H. & T. 275 deg. C.	H. & T. 450 deg.C.
20.7	49.1	45.2	168	475	412
29.1	41.0	42.3	210	410	380

which has come to be known as "sooty graphite," whereas the second specimen showed normal graphite under the microscope and a characteristic bright fracture. In spite of the initial absence of combined carbon, specimen No. 1 hardens readily on quenching in oil from 875 deg. C. and attains a higher hardness value than No. 2 in hardening and tempering. In the "as-cast" condition, the lower strength-value characteristic of the ferrite-fine graphite structure is found in specimen No. 1, but in spite of this, an increment of over 150 per cent. in strength is attained by hardening and tempering and the strength value attained is almost 25 per cent. higher than that attained by the coarse-graphite specimen. Not the least important of the possible lines to be pursued in further investigation is indicated by results of this order.

This reference to the effect of the graphite reminds me of the necessity of making further reference to the heat-treatment of malleable cast iron. Experimental work has shown that all varieties of malleable cast iron respond to hardening and tempering treatments and the effect on the strength properties of hardening and tempering treatments have characteristics similar to those outlined above. In this case, the elongation properties have to be taken into consideration also, and here it is possible to bring about a variety of changes by suitable heat-treatment. One important deduction from experimental results already published, for ex-

OUTSIDE THE HOTEL AT ASHOPTON.

This group was taken on Friday's excursion into Derbyshire. In the picture (left to right) are: Mr. Bigg, Mrs. Everest, Mr. Hurst, Mrs. Bigg, Mr. Stobie, Mrs. Stobie and Mr. W. A. Geisler.

Photos by Courtesy of Dr. A. B. Everest

AT THE GARDEN PARTY ON FRIDAY.

The garden party was held at Hope, and the group shows: (Back row) Mr. Bigg, Mr. Makemson, Mr. Stubbs, Mr. Winterton, Mr. Whiteley and Mr. Walker; (seated) Mrs. Bigg, Mrs. Hurst, Mr. Hurst, Mrs. Winterton, Mrs. Walker and Mrs. Stubbs.

ample, is that with a suitable heat-treatment by hardening and tempering, the properties of black-heart malleable can be made to resemble closely those of good white-heart malleable. This serves to emphasise a point of view that heat-treatments of this type are available for use in obtaining modifications in the mechanical-strength properties, and their sole value does not lie alone in their ability to produce hardened surfaces. This applies with equal force in the application of such heat-treatments to grey cast irons, and, I venture to predict, will assume far greater importance in the future metallurgy of cast iron.

Nitrogen Hardening

Quite a different form of heat-treatment is the nitrogen hardening process. This belongs essentially to the category of case-hardening processes and is carried out by subjecting the articles to the action of anhydrous ammonia gas at a temperature of approximately 500 deg. C. This process, familiar in its application to suitable steels, was first extended to cast iron and a suitable alloy cast iron, now known as Nitricastiron, developed by the firm with which I am associated. This alloy cast iron is an aluminium-chromium alloy, and by treatment in ammonia gas, as mentioned, is capable of yielding surfaces of 1,000 Firth Diamond hardness and over. This is a development in the field of heat-treatment of cast iron as unexpected as it is pronounced, and has proved to be one of the utmost commercial importance. Its extension to other alloy cast irons is being actively pursued, and particularly in the case of austenitic cast irons it promises to be of equally great importance.

Temper Hardening

The discovery of hardening effects in alloys as a result of tempering, ageing and similar treatments is a general metallurgical development which has had important commercial results. Effects of a similar character have been noticed already in certain alloy cast irons, particularly those irons which come within the class known as austenitic cast irons. An interesting example of this is that of a nickel-manganese austenitic cast iron to the following composition:—Total carbon, 2.65 per cent.; combined carbon, 1.00; graphite, 1.65; silicon, 1.81; phosphorus, 0.074; sulphur, 0.025; manganese, 3.75; nickel, 6.50 per cent.

From a study of the dilatometer curves which revealed inflections at temperatures in the neighbourhood of 500 and 850 deg. C., it was concluded that in the normal condition the material was austenitic.

On passing a temperature of 500 deg. C. the austenite commenced to transform into martensite which was again transformed to austenite on passing the higher temperature of 850 deg. C. This alloy is clearly susceptible to temper hardening, due to the precipitation of martensite. The strength properties undergo a sharp increase on heating to 500 deg. C., and on heating to a further temperature in excess of 850 deg. C. the hardness and the strength values are lowered to approximately that of the original material.

In this necessarily brief review of the modern developments in the application of heat-treatments to cast iron, it is legitimate to take the view that their development, which is by no means small, has arisen out of the confidence inspired by the results of the research and investigation into the properties as affected by such heat-treatments. As in the case of other branches of metallurgy, they have assumed already a position of considerable importance. This may justify the selection of the subject for this presidential address, out of all the other truly remarkable developments in connection with the metallurgy of cast iron, which we have witnessed in this Institute during the last quarter of a century. These developments have made the metallurgy of cast iron quite a definite and distinct section of metallurgy. On all sides it has been recognised that remarkable advances have been made, but it is of greater importance to recognise that still further advances are possible. It is to be hoped that the developments in foundry education will direct the attention of students to this section of metallurgy and enable them to participate in its future progress. During the last year the Sheffield University has organised within its Faculty of Metallurgy a foundry degree course of training leading to a degree in foundry metallurgy. This opportunity for marked specialisation has been still further increased by the founding of the British Foundry School in Birmingham.

In closing, I propose to draw again on Prof. Turner's address to this Institute in 1909, over 25 years ago. It is now actually over 50 years ago since Prof. Turner presented his classical Paper to the Chemical Society in July, 1884. Prof. Turner is still with us, enjoying good health and full activity. As an honorary member of our Institute, we are proud to congratulate him on passing the Golden Jubilee of his monumental Paper. Foundrymen throughout the world will share with him the immense pride in contemplating the more recent developments in the metallurgy of cast iron, of which he laid the foundation stone. The paragraph I would choose from his address of 1909 on which to close applies to-day with equal force as when uttered: "*Remarkable as have been the increases of knowledge during the past quarter of a century, it must not be supposed that all has been discovered, or that finality has been reached. In many directions we are yet only in the gateway of knowledge, and for the young and energetic investigator who has had the requisite training and skill, the field is as wide as ever before. Rather, it should be said, it is wider, for every firm foundation securely laid is but a stone on which to build, and through each doorway, which has now been opened, the earnest student sees long corridors as yet untrod.*"

Vote of Thanks to the President

MR. ROY STUBBS (immediate Past-President), proposing a vote of thanks to the President for his address, said that one always expected something original from him, and by his presidential address he had certainly added to the many important contributions he had made previously to their knowledge.

MR. H. WINTERTON (Senior Vice-President), seconding, also paid a tribute to the President; he commented with gratification on the fact that Prof. Turner, to whom reference was made in the address, was present at the Conference, and was still taking the greatest interest in the Institute; they all hoped sincerely that he would be spared for many years to continue his interest in it.

The vote of thanks was accorded with acclamation, and the President briefly replied.

The First Edward Williams Lecture

The PRESIDENT, in calling upon Sir William Larke to deliver the first Edward Williams Lecture, recalled that more than a year ago the Literature Committee and the Council of the Institute had decided, in order to commemorate the very happy presidency of Mr. Edward Williams, to found an annual lecture, modelled somewhat on the annual lectures delivered before other scientific institutions both in this country and abroad. It was decided that the lecture each year should be delivered by a man who was prominent in his own sphere of industry or science and had taken an active part in the development of various aspects of scientific and industrial work.

Sir William Larke was so well known to the majority of those present that no formal introduction was necessary.

SIR WILLIAM LARKE, in his preliminary remarks, expressed his appreciation of the honour the Institute had done him in electing him an honorary member. Whilst it did not need that compliment to cause him to retain his interest in the progress and welfare of the Institute, one did appreciate the confidence of one's fellows, and he was indeed happy to receive such an honour from men whom he really knew, knowing that the honour was really meant.

Edward Williams Lecture

MAN AND METAL

By SIR WILLIAM J. LARKE, K.B.E. (Director of the British Iron and Steel Federation)

I am deeply sensible both of the honour and of my own inadequacy in being invited to deliver the first Edward Williams Lecture, founded out of compliment to our former President, Mr. Edward Williams, as a mark of the esteem in which he is held by the members of this Institute and in recognition of his particularly successful year of office. We all appreciate how greatly he distinguished that office by his assiduous attention to the duties and responsibilities of the position. May I be permitted to add that Mr. Williams was No. 1 on the roll of the University College of Cardiff when it was founded some fifty years ago. We trust that we may long have him with us to add wisdom to our Councils and distinction to our membership.

When we consider our dependence on metals to-day, their paramount influence on the development of mankind and our intellectual and material civilisation, it is remarkable that, although it is generally accepted that man first appeared on the earth 300,000 years ago, there is no conclusive evidence that he had any knowledge of metals earlier than 4,000-5,000 years before the Christian era; say the last 7,000 years. It is only in the last 200 years that metals have rendered possible that revolution which converted handicraft into industry. During the present century more metals have been produced than during the whole period of historic time preceding the year 1900.

Immediately preceding the Metal Age was the Neolithic or late Stone Age. Knives, scrapers and weapons consisted of stones selected or chipped into shape for the purpose required. A considerable degree of skill in their manipulation was developed, particularly when it is borne in mind that the stone used was largely flint. The earliest use of metal was in its native form, when it was considered as a malleable stone.

Rickard in "Man and Metals" assumes that there was a transitional period between the Stone and Metal Age, which he has called the Chalcolithic or copper stone period. Copper was the first metal known, at least in the Ancient World, Egypt and the East, where the evidence of actual specimens is supported by writing and pictorial representation. According to Partington there is evidence that in pre-historic times galena or lead sulphide, which was probably not recognised as a metal, and malachite, natural copper carbonate, were used as eye paints.

Copper Smelting

Copper smelting was probably discovered about 4500 B.C. and no doubt accidentally. One authority suggested that a woman of the period dropped her malachite face powder or paste accidentally into the fire and the resulting copper bead was discovered. Most authorities, however, agree that it is much more likely, as with all metals, that smelting was an accidental discovery

following a camp fire which had been built in a circle of stones containing ore, and that beads of copper were observed on the stones when the fire was extinguished and recognised as being the same as the native metal with which they were already familiar. This is substantiated by a similar experience recorded in modern times in the copper-bearing districts of Rhodesia.

The working of copper appears to have reached a relatively high standard in very early times, as prior to 3400 B.C. worked copper included sheet and wire needles with eyes bent over as loops, pins, beads, bracelets and copper bands. The wire was made by slitting sheet, which latter had been produced by hammering, and the slit strip was actually hammered round. About 3000 B.C. copper was used for bolts and nails, hinges, wrought table vessels, cups and even doors. A copper welded drain pipe 4.7 cm. in diameter and 1.4 mm. thick was discovered on a site indicating that it had been 400 m. long, and could be dated 2500 B.C.

Following copper was, if not the discovery, which probably preceded copper, at least the use of gold for decorative purposes about 3500 B.C. It was used in the form of a thin leaf for gilding teeth, finger nails and toe nails. Gold leaf was also applied to copper with stucco; firing was not understood until much later. The development of smelting brought more metals to the notice of man. Bronze, which appears about 1,000 years later than copper, was the result of smelting mixed ores, and tin was not separated until much later.

Bronze represented a considerable advance with its lower melting point, and greater beauty and hardness. Ancient bronze varies in its constitution from about 77-95 per cent. copper content. Bronze and copper roofs are mentioned as being used in Babylon. Bronze daggers, razors and weapons were common in Egypt in 2000 B.C. It is suggested that the discovery of bronze was probably made in Khorasan, Northern Persia, where tin and copper are mined together.

Lead, produced before 3400 B.C. in sheet form, was actually used as a damp course in the walls of Babylon. It was not, however, used to any great extent until the 6th century B.C., when it was used for water tanks. Brass, which was probably also an accidental alloy, was known in Palestine as something distinct from copper about 1500 B.C. Some confusion exists with regard to it, owing to the application of the term by early writers to a variety of metals and alloys, such as copper, electrum, bronze and even alloys of iron.

Partington, in "Origins and Development of Applied Chemistry," to whom I am indebted for much of this chronology, says that zinc oxide is mentioned as an eye salve in the Ebers Papyrus in 1550 B.C., and antimony is also mentioned as a medicine in this case for internal use. Mercury was imported into Egypt between the 15th and 16th centuries B.C., presumably from Spain. Copper, which was largely used for tools and weapons, being hardened by cold-working, was subsequently replaced by bronze, which was harder still and could be made to take something of an edge, and which formed the basis of weapons even up to Roman times. It was, however, the discovery of iron which gave the greatest impetus to the development of man, both intellectually and materially.

Meteoric Iron

There seems no doubt that the earliest iron worked by man was of meteoric origin. Zimmer, who examined this question very thoroughly, seems to have demonstrated conclusively that this was almost certainly the case. He has proved that at the date of his examination (1916) upwards of 90 per cent. of the then known meteoric iron (250 tons) was ductile.

The earliest iron remains contain a substantial percentage, upwards of 3-7 per cent., of nickel, characteristic of meteoric iron. This explains the observed freedom from corrosion and the ability to take an edge, which has characterised some of the earliest iron weapons. The meteoric origin of iron is supported by the traditional name for iron in many cultural languages, which, when literally translated, means something hard from Heaven. A Pyramid text of 2750-2450 B.C. calls it "metal of heaven." A Hittite text of 1400 B.C. mentions black iron from the sky (Rickard).

Cortez, in the early part of the 16th century, when he conquered Mexico, discovered that the Aztecs valued iron knives and daggers far above their gold, and when asked how they produced it, they said it came from the sky. It is a curious commentary that these statements were dismissed as mythical, and, according to Zimmer, it was not until April 26, 1803, when a shower of meteorites was observed at L'Aigle, Normandy, by some thousands of people, that the celestial origin of meteoric iron was accepted in modern times.

Smelting of Iron

The date and place of the origin of iron smelting cannot be definitely determined. The earliest iron weapon discovered in Egypt was a spearhead of about 2000-1800 B.C. This must have been imported. There is evidence that iron was used in Babylon about 2500 B.C., and became comparatively common in 1400 B.C. in the form of steel showing carburisation. The smelting of iron as a craft appears to have originated on the shores of the Black Sea, where there was available a particularly pure magnetic iron sand. The Taurus Mountains and the foot of the Caucasus are also suggested, as the local ore contains manganese, and a good-quality iron was produced.

The most famous iron remains in Europe are the finds in the graves at Hallstatt, Carinthia, Austria, of iron and bronze weapons of similar types and shapes, indicating the transition from the Bronze to the Iron Age. These can be dated at about 1200 B.C. The Iron Age in India has also been dated between 1400 and 1300 B.C., where there was a highly-developed iron craft in Hyderabad, from which originated the famous Indian steel called wootz, produced by a cementation process, similar to that invented by Huntsman in 1740. Although iron was reduced from the ore, it was not melted, since the temperature could not be raised in primitive furnaces to its melting point. The iron produced was a spongy mass mixed with silica and ash and other impurities. It was purified by continual reheating and hammering, and although there was some evidence to show that cast iron was occasionally produced, it was rejected as being brittle and non-malleable.

Originally the smelting of ore was carried out simply by a fire laid in a hole in the ground, ore and fuel being mixed together, and the temperature reached was simply that obtainable by natural draft or by surface fanning. There was then added a clay lining to the hole, the addition of a trench in the ground leading to the hole in the direction of the prevailing wind, and finally to a small superstructure above the ground, in which were inserted clay pipes or tuyeres at ground level, through which was blown an artificial blast from skin bellows. The clay lining of the furnace was the forerunner of the crucible and the superstructure and bellows of the blast furnace. There is pictorial evidence of the use of bellows in Egypt in 1500 B.C., but the liquefaction of iron had to wait upon the use of the power-driven bellows which were not available until the 14th century A.D., when they were driven by water wheels. Thus, Rickard points out, there was a period of 2,500 years between the making of wrought iron and the art of casting it.

Iron as Currency

The Iron Age does not seem to have commenced in Britain until about 400 B.C., and Ault suggests that from the general introduction of iron tools and weapons may be dated the development of man from a hunter into a farmer. As the result of storing food supplies, domesticating animals and through the exchange of food for tools and weapons, he became a trader and a capitalist. It is significant that iron was used as currency in the shape of bars in this country, a practice that was probably introduced from the East, since Rickard records that a store of iron belonging to King Sargon II at Khorsabad, 722-705 B.C., consisted of bars of iron from 9 to 12 in. long and 2¾ to 5½ in. thick, weighing 9 to 44 lbs. each, the total weight being 176 tons, each bar being pierced at one end for transport. Included with this store were many finished articles, such as chains and horses' bits, etc.

From this period for the next 2,000 years, while the use of metals became more common, it may be said that their application did not change in character. The principal advance was the introduction of cast iron about A.D. 1340. Cast iron was not converted into malleable iron until the invention by Cort of the puddling furnace 440 years later. Thus, while metals were made to contribute to the welfare and comfort of mankind over a wider area, the technology of their production and use made comparatively small advance. Richardson, in "Prehistoric Iron," says the chemistry of the process (of the production of iron) was as vague to the European of A.D. 1700 as to his Celtic predecessors.

The products of the early craftsman, 2,000 to 3,000 years B.C., were as good of their kind and showed a degree of skill at least equal to that shown by the craftsmen in similar things up to even the 16th and 17th centuries. In the later centuries, of course, mechanism developed to an extent previously unknown, producing clocks, combination locks and other things of this kind made of iron. As production was simplified and the use of metal tools for agriculture and handicrafts generally, as well as for weapons of war, became more widespread, they became available to a much greater number, and thus unquestionably raised the standard of life of the people as a whole. No doubt this development also tended to create classes of society, since metal tools and weapons were a form of wealth which could be accumulated, and those who possessed them obtained a measure of economic and physical advantage over their fellows.

Three Phases of Industrial Development

In this country there have been during the historic period, say from the date of the Norman Conquest, three main phases of industrial development. The first and longest was a continued development of metal handicraft, and lasted until the early part of the 18th century, the second the age of coal and iron, and the third commencing with the present century, the age of alloys and electricity. The second phase lasted only a century and a half, and dated from what has been aptly described by Rickard as the marriage of iron and coal, the High Priest of which was Abraham Darby, who first used coke in blast furnaces in 1735, after experimenting for some years. To obtain his blast he used a water wheel some 24 ft. in dia. and pumped the water from his lower mill pond into the upper with a Newcomon fire engine. This application coincided with the improvements in the steam engine, due to James Watt, which provided the blowing power enabling the iron masters to produce iron in bulk at a much lower cost than was previously obtainable. This made possible the development of the steam engine and all that flowed from it, by providing the materials in the form of cast and wrought iron in quantities which permitted the application of the steam engine for pumping and general power purposes.

The Railway Era

There followed within the next century perhaps the most active period in human history of invention and economic and cultural develop-

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ment. Stephenson's first locomotive in 1815 marked the birth of the railway era. Rails were originally of cast iron, then of wrought iron, made possible by the invention by Cort of the puddling furnace and grooved rolls in 1783 and 1784 respectively. The first steel rail made at Dowlais in South Wales was laid in 1857. In less than a century, according to Carpenter, there were no less than 800,000 miles of railway laid in the world.

In this country railway development was very rapid. Whereas in 1840 there were 1,331 miles of track, by 1890 this had reached 20,000 miles. The reason was the rapid development of the Machine Age between the middle of the 18th and the middle of the 19th centuries. The conversion of handicrafts in the home to industry in the factories had proceeded with such rapidity that industrial production had outstripped the capacity of accessible markets to absorb it. Only horse transport was available, or to a limited extent water on the coast and inland rivers. Industries had been located where coal and other raw materials were to be found, such as the Black Country for the metal industries and Lancashire and Yorkshire for the textile industries. The railways found immediate employment in transporting the surplus industrial production to markets further afield, and also in opening up new sources of supply of raw materials.

It is remarkable how short a period has elapsed since the speed of transport exceeded that of the horse. It was as late as 1829 that Stephenson's Rocket won £500 for maintaining an average speed of 44 miles per hour over 35 miles. In 1904, 102.3 miles per hr. was reached on the Great Western from Plymouth to London, and during the present year the L.N.E.R. reached 108 miles per hr. in ordinary running between Grantham and Peterborough. As regards the motor car, Sir Malcolm Campbell reached 272.82 miles per hr. at Daytona on March 7 of this year. The aeroplane record is held by Italy 423.57 miles per hour, being attained at Lake Garda on April 10, 1933. The "Normandie" has recently maintained an average of 30.91 knots for 24 hours in crossing to America.

The Electric Age

At the beginning of the 19th century the discoveries of Volta, and particularly that of electro-magnetic induction by Faraday in 1831, mark the birth of the Electric Age in which we are now living. Although the dominant metal is iron and its various alloys, this discovery brought copper into its own. First, the invention of the telegraph in the early forties by Wheatstone and others, the development of the dynamo for electro-plating in the forties and for electric light in the next decade, marked the beginning of the era of the electric transmission of power. From the small ring, 6 in. in dia., which Faraday made to demonstrate electro-magnetic induction, has grown the modern electric transformer of 100,000 kilowatts. From the fine copper wires used for transmitting the small battery current required for telegraphy between Euston and Chalk Farm in 1843, has developed not only the cables which cross the oceans of the world, but the electric transmission systems which form a network covering most of the industrial countries.

In this country the electric grid already comprises 4,000 miles of transmission line, and is the result largely of the development in the last twenty years of the production of aluminium, the most efficient electrical conductor per unit of weight, which was only discovered in 1825—little more than a century ago. It remained throughout the 19th century something of a curiosity, but is now one of the most important metals and seems destined to fill an even more important *rôle* in the future.

In the electric grid in this country 12,000 tons of aluminium have been used for transmission lines, and the supporting towers have required 150,000 tons of steel. At Dagenham the span across the river is 3,060 ft. and the towers to support it are the highest in the world, being 487 ft. high, upwards of 80 ft. higher than the cross of St. Paul's, weighing 290 tons each. A special alloy has been used for the lines of phosphor-bronze and cadmium.

Cast Iron as Structural Material

Although the present appears to be dominantly a Steel Age, actually cast iron is still one of the most important structural materials. The necessity of increasing its malleability and tensile strength has resulted in the production of cast iron with a tensile strength of 32 tons per sq. in.; and of a foundry technique which can provide it with a glass-hard surface and capacity in the body of the metal to withstand substantial shock.

We are apt to forget what an important structural material cast iron is to-day. The tube railways of London are built of cast-iron sections, of which approximately 1,000,000 tons is already erected. The latest development of this technique is the tunnel under the Mersey between Liverpool and Birkenhead, which contains no less than 80,000 tons of cast iron. The road is paved with cast-iron blocks with non-skid glass-hard surface.

The evolution of the use of metals appears to have passed through a stage, first by manipulation by forging, secondly, by casting, and then—the present method—casting and subsequently mechanical manipulation, forging, rolling, etc. All metals used to-day are first cast before they are otherwise treated or manipulated, and it is at the casting stage that the metals or alloys receive their basic characteristics on which depend their ultimate qualities. It is for this reason that we have no less than four important research organisations dealing with casting: the Cast Iron Research Association, the Steel Castings Committee, the Heterogeneity of Ingots Committee and the Non-Ferrous Metals Association, which is doing important work on casting.

Sheffield, which was known for its cutlery in the days of Chaucer, occupies a prominent position as the centre of metallurgical discovery and development during the present century, which has rendered modern engineering achievement possible.

Manganese and Silicon Steel

Manganese and silicon steel were discovered by Sir Robert Hadfield in the eighties of last century, but it was not until 1903 that the properties of silicon steel for use in electrical transformers and machines began to be appreciated; it has been used generally since 1907. Its use resulted immediately in halving the magnetic iron losses, and to-day the losses which represented 5 per cent. of the output before the introduction of silicon steel are reduced to between 1 and 2 per cent. It is not too much to say that modern electric transmission and the large generating units now used would have been impossible without this discovery.

Manganese steel, owing to its wearing qualities and resistance to abrasion, giving twenty to thirty times the service of steels used previously, has exercised a profound influence on railway development, and has made available heavy machinery for civil engineering work which otherwise could never have been undertaken.

Discovery of Chromium-Nickel Steels

One of the most important metallurgical developments of the last twenty years has been the production of a series of steels containing varying amounts of chromium and which, when tested in nitric acid, were found to have progressively increased passivity proportional to the increase in chromium. This phenomenon, discovered at the Brown-Firth Laboratories, Sheffield, by Mr. Harry Brearley in 1913, may be said to have introduced an entirely new field of application for rustless steel in cutlery, industrial machinery, chemical plant, steam turbines, valves for all purposes, and other uses too numerous to specify, where high mechanical properties and non-corrodibility are essential. It is even largely used for decorative purposes, particularly where exposed to atmospheric corroding influence.

This series of chromium-nickel steels has already been developed with a wide range of mechanical and heat-resisting properties. It may be claimed as one of the greatest discoveries of the present century, the full extent of the application of which cannot yet be foreseen.

In the case of tool steels, of which again Sheffield is the recognised centre of origin and production, the progress during the present century is remarkable, and illustrates the important contribution of the rarer metals when alloyed with iron in the production of materials on which we are to-day dependent. In the early part of the century, about 1910, steel containing 0.6 to 0.8 per cent. of carbon, 3 to 4 per cent. of chromium, 18 per cent. of tungsten and 1 per cent. of vanadium, had given a cutting speed of 3 lbs. per min.

Cobalt was the next element, and certain tool steels to-day, containing carbon, chromium, vanadium, cobalt and molybdenum, are capable of removing 10-12 lbs. of metal per min. and retain their hardness at red heat. Thus manganese steel, which previously was considered for all practical purposes non-machineable, is now machined quite successfully.

Still harder alloys of non-ferrous metals for cutting tools are now available, such as stellite, a cobalt-chromium-tungsten alloy and another class known as the tungsten-carbide alloys, are made by compressing metals in powdered form with the addition of cobalt to provide cohesion. These are capable of removing 16.8 lbs. of metal per min. The importance of these non-ferrous alloys is that their hardness is such that many materials previously considered unmachineable can now be machined, including glass, porcelain, hardened steel and chilled iron. The extension of power which these products give to the engineer is almost incalculable. The development of steels with higher tensile properties has also enabled the engineer to use higher peripheral speeds, and higher pressures at higher temperatures in steam turbines. While the credit is the engineer's, the realisation of his inventive genius was not possible until metals capable of withstanding very high stresses at high temperatures were available.

To-day it is possible to build turbines of 30,000 kilowatts running at 3,000 r.p.m. The higher steam pressures used are only made possible by the use of steels of the nickel-chromium-molybdenum series. It has been proved possible to operate a turbine successfully of 10,000 kilowatts, 3,600 r.p.m., continuously at a temperature of 1,000 deg. Fah. Similarly, the peripheral speed of turbine buckets has increased from 870 ft. per sec. in 1918 to 1,250 ft. per sec. in the present day, solely on account of the improvement in materials which has resulted from the work of the research laboratories of the steel industry in Sheffield and elsewhere.

Aviation and the Motor Car

The contribution of metallurgy to aviation is equally great. The first radial aero engines, which are about 15 years old, weighed 2 lbs. per brake horse-power. In the latest type this has been reduced 1.2 lbs. The six-cylinder engines used during the war had a weight of 2.65 lbs. per brake horse-power. The most modern engine of a similar type in normal use weighs under 1½ lbs. per brake horse-power. The Schneider Trophy engine weighed ¾ lb. per brake horse-power. This was designed for a limited period of service, whereas the ordinary aviation service requires that an engine should run for 500 hrs. without a serious overhaul. However, authorities I have consulted consider it probable that aircraft engines for ordinary service in the

near future will be reduced to a weight of about 1 lb. per brake horse-power.

The development of the motor car during the present century is equally impressive, largely due to the development of light alloys. In 1900 the maximum piston speed was of the order of 1,500 ft. per min. To-day 3,200 ft. per min. is common practice. Whereas in 1900 a 10-h.p. engine was of the order of 3.5 litres cylinder capacity at a maximum speed of 1,600 r.p.m., to-day a similar engine has a capacity of 1.2 litres and a maximum speed of 4,500 r.p.m. The output of the 10-h.p. engine has increased from approximately 17 to 30 brake horse-power, 1.8 times, due to the increase in mean effective pressure and piston speed, both of which have only been made possible by metallurgical progress.

Of recent engineering triumphs, perhaps three of the most outstanding based on steel are in order of time the Sydney Bridge with a span of 1,650 ft. across Sydney Harbour, the arch of which contains 38,000 tons of special high-tensile steel, which alone may be said to have rendered this design practicable; the Irak oil pipe line, 1,200 miles long, a triumph not only of civil engineering, but of the production and manipulation of the material of which it is made, being welded throughout, including the joints; the "Queen Mary," which, when launched, was claimed to be the largest mass—40,000 tons—ever moved by man unaided by mechanical power.

The Duralumin Alloys

The duralumin series of alloys, invented in the present century, consisting of approximately 90 per cent. aluminium with varying proportions of copper, manganese, magnesium, silicon and iron, having the strength and hardness of mild steel and only approximately one-third of its weight, has made modern aviation possible, in the design of the aeroplane.

The increasing use of the rarer metals is a particular feature of the twentieth century; osmium, tantalum, tungsten in lamps; magnesium, chromium, tungsten, molybdenum, vanadium, cobalt, nickel, beryllium, cadmium alloyed with iron, and also copper, lead, generally in very small proportions, provide, however, the dominant influence in producing the characteristics of the alloys of which they form a part. Radium and selenium have more special applications. The application of these rarer metals has enabled the efficiency of electric incandescent lamps to be increased from 3.1 lumens per watt to 11.5 within the last thirty years. The consumption of lamps in the British Isles for ordinary service has increased from 20 millions in 1922 to 65 millions in 1934. The cost per unit of light has been reduced to one-third, when calculated on a rate of only 2d. per kilowhatt hour.

Broadcasting, the full significance of which cannot yet be appreciated, is perhaps the most remarkable application of scientific discovery in our daily life, and this is ultimately dependent on the work of the metallurgist. This brief summary shows that metallurgical progress in the present century has been almost as great as in the whole previous history of mankind.

World Production

The growth of the Metal Age cannot be better illustrated than by a comparison of the world production of the various important metals since 1900 up to recent times. The following table has been specially prepared by the Mineral Resources Department of the Imperial Institute. From 1900 to 1929, the peak year, the world production of steel was multiplied over four times, of copper approximately four times, and of aluminium no less than 35 times. Although the quantities of the rarer metals are much smaller, the rate of increase in their production is no less impressive and significant.

If this brief survey has demonstrated the important part which metallurgists have played in the development of our modern material civilisation, it none the less indicates the potentialities of the future and the consequent responsibility which rests on the metallurgical industries for continued research, not only to meet demands which engineering is making for new materials, but for the provision of improved materials to stimulate this progress.

Unexplored Territory

A new industrial revolution almost unnoticed is in progress, pregnant with far-reaching results for the future. It is based on the almost daily discovery of new materials having new properties capable of standing increased stresses under all kinds of varying conditions of static or dynamic load within wide ranges of temperature. Lord Rutherford recently stated that: "It was now known that the tensile strength of a piece of steel was not much more than 1 per cent. of what it ought to be in a properly-designed and conducted world. The fault apparently lay with the presence of microscopic cracks in a crystal, and one could well imagine some genius coming along and showing how those cracks could be eliminated."

We only require to imagine the effect of increasing the present limits of tensile strength by two or three times to see that the design of our structures would undergo a complete revolution, and the stimulus to engineering invention might well produce results transcending our imaginative powers.

It is a matter for real gratification that every new discovery and achievement opens up an ever-wider horizon of unexplored territory. Thus the quest of the scientist and the engineer for further knowledge and achievement can never be ended. Thus the zest and sense of adventure remain and provide the greatest stimulus to progress. Metals are therefore much more than the material basis of the amenities of life, their development and application is continuously providing a stimulus to the intellectual growth of man.

WORLD'S PRODUCTION OF MORE IMPORTANT METALS.

Long tons (except Gold (oz.), Silver (oz.), and Quicksilver (lb.)).

	1900.	1929.	1933.	Ratio, 1929/1900.
Steel	28,300,000	118,300,000	66,700,000	4.2
Manganese ore	1,600,000	3,600,000	1,760,000	2.2
Chrome ore	40,000	590,000	278,000	14.8
Nickel	8,000 (est.)	55,000	45,300	6.9
Cobalt	100 (est.)	1,100	1,100	11.0
Tungsten (WO_3)	300 (est.)	9,400	6,600	31.3
Vanadium	1 (est.)	1,250 (est.)	100 (est.)	1,250.0
Molybdenum (MoS_2)	30	3,200 (est.)	4,800 (est.)	107.0
Copper	490,000	1,890,000	1,030,000	3.9
Lead	840,000	1,790,000	1,160,000	2.1
Zinc	470,000	1,140,000	990,000	2.4
Tin	95,000	189,000	96,000	2.0
Aluminium	7,500 (est.)	267,000	138,000	35.6
Antimony	7,500 (est.)	29,000	20,000	3.9
Gold	12,400,000 troy oz.	19,400,000	25,000,000*	1.6
Silver	174,000,000 ,,	265,000,000	171,000,000	1.5
Quicksilver	7,300,000 lbs.	12,400,000	4,100,000	1.7

* Russian production estimated.

The Production of Iron—Ancient and Modern

At the conclusion of his lecture, Sir William exhibited a cinematograph film illustrating ancient and modern methods of producing iron. He was able to depict the ancient method by the courtesy of Mr. Harold Cookson (Past-President of the Staffordshire Iron and Steel Institute), who had brought the film from India. It was taken by Mr. Blundell, one of the managers of the Tata Company, who was living within 200 or 250 miles of a tribe the members of which were still making iron in the mediæval fashion. This iron craft, which was still practised in parts of India, West Africa and many other parts of the world, was a traditional tribal craft, handed on from generation to generation. In the process illustrated, the natives built a small superstructure of puddled clay, using elementary tuyeres and goat-skin bellows, the bellows being worked by various members of the family in turn, using their feet. The iron, which was extraordinarily pure, was produced in the form of a sponge. Each time the iron sponge was taken out of the furnace, the mouth of the latter was wrecked and had to be re-made. In a period of 12 hrs., from 15 to 30 lbs. of iron was produced. The film showed the lighting of the furnace by blowing in lighted charcoal. Ultimately the furnace was sealed at the top, except that a small hole was left to allow the draft to get out. The tapping hole for the slag was not permanent, but was made where it was wanted. The capital cost of the plant was 4 rupees, and Mr. Blundell had paid 15 rupees for the iron produced.

By the courtesy of many friends—the Brown-Firth Laboratories, Messrs. Lysaght and others—Sir William was able to show the section of film illustrating modern iron and steel smelting. A particularly attractive feature of the film was its excellent portrayal of the condition of molten steel inside a Héroult electric furnace.

Vote of Thanks

PROF. J. H. ANDREW, proposing a vote of thanks to Sir William Larke for his lecture, said all would feel that justice and honour had been done to Edward Williams, whom they held in such high esteem and regarded with sincere affection. It was particularly fitting that the first Edward Williams Lecture should have been delivered by Sir William Larke, for not only was he a great speaker, but, as the Master Cutler had pointed out, he had done a great deal for the iron and steel industry politically and otherwise; all present appreciated how much he had done for the industry, particularly in regard to research. Reference had been made, in the course of the lecture, to the Corrosion Committee and others, which were working under the able chairmanship of Dr. Hatfield, who would be the first to agree that the success of those Committees had depended largely upon what Sir William had done in affording them heart and encouragement and in providing financial means.

The members deeply appreciated Sir William's lecture, and the film which he had brought at his own expense; even men of Sir William's outlook and energy could enjoy a good "movie." He had dealt with metals for many years, and he had always been sympathetic to man. His lecture was delightful.

MR. V. C. FAULKNER (Past-President), seconding, said it was particularly appropriate that Sir William had chosen the subject "Man and Metal" for the first Edward Williams Lecture, for the study of early processes for producing metals was Mr. Williams' hobby, and he was searching for the earliest casting. He had recently visited the Far East in the prosecution of this research, and seemed to be on the eve of making the momentous discovery that all we

have now had existed in China at the time of the Ling Dynasty.

There were two phases in the career of Sir William Larke which had not been touched upon by either the Master Cutler or Prof. Andrew. In the first place, the country was very much indebted to him during the war for having brought out of chaos into order the requisitioning of materials for the prosecution of the war. That, indeed, was a very, very great work. The second phase to which no reference had been made that morning was his past connection with the Institute, particularly the London Branch. He had acted as the Institute's liaison officer with the great iron and steel industries, and time after time he had taken more interest in its work than had any other leader of thought in the iron and steel industry.

The vote of thanks was enthusiastically accorded, and SIR WILLIAM briefly responded.

The meeting then concluded with the presentation and discussion of Papers.

Luncheon

The members and their friends were entertained to luncheon at the Grand Hotel, Sheffield, on Wednesday, by the Sheffield Branch.

MR. A. WHITELEY (President-Elect of the Branch) offered a hearty welcome to Mr. and Mrs. Hurst and to all attending the Conference, and expressed the pride of the Branch in the fact that in this Jubilee year one of its members should have attained the highest honour that the Institute could bestow. If, he said, Mr. Hurst had what he deserved, he would enjoy a very happy and prosperous year as President; the prestige of the Institute was great, and when the time came for Mr. Hurst to hand on his high office to his successor, he would be able to do so with the certain knowledge that the Institute was better and stronger by reason of his presidency.

The members and their friends had been welcomed by the Lord Mayor of Sheffield (who had also entertained them), by the University, by the Master Cutler and by the President of the Sheffield Chamber of Commerce. On behalf of the Sheffield Branch, Mr. Whiteley also extended a hearty welcome, and expressed the hope that the arrangements made for their welfare and entertainment would be to their liking.

Visits to Works

On Wednesday afternoon parties visited the works of Messrs. Steel, Peech & Tozer, Limited, Messrs. Hadfields, Limited, the Sheepbridge Stokes Centrifugal Castings Company, Limited, and the Foundry Department of the University of Sheffield.

Annual Banquet and Dance

The Institute's annual banquet, followed by entertaining and dancing, was held at the Royal Victoria Hotel on Wednesday, July 3, and afforded an opportunity to entertain some of the many friends who had helped so much to make the Conference a success.

The PRESIDENT (Mr. J. E. Hurst) presided over a distinguished gathering, which included the Lord Mayor and Lady Mayoress of Sheffield (Alderman and Mrs. P. J. M. Turner), the Master Cutler (Mr. Alexander Williamson), Sir Harold Carpenter, F.R.S. (President, Iron and Steel Institute), Mr. A. K. Wilson (President, Sheffield Chamber of Commerce) and Mrs. Wilson, the Mayor and Mayoress of Chesterfield (Alderman H. Varley, J.P., and Mrs. Varley), Commander Sir Charles W. Craven, O.B.E., R.N., Mr. J. Ward, J.P., and Mrs. Ward, Mr. A. J. Grant, J.P., and Mrs. Grant, Mr. A. Whiteley (President, Sheffield Branch of the Institute) and Mrs. Whiteley, Mr. and Mrs. A. B. Winder, Mr. E. B. Gibson (Town Clerk of Sheffield) and Mrs. Gibson, Dr. W. H. Hatfield, F.R.S., and Mrs. Hatfield, Mr. and Mrs. P. B. Henshaw; Mr. F. M. Fisher (President, Refractories Association of Great Britain) and Mrs. Fisher, Mr. W. M. Gibbons (Registrar of the University of Sheffield) and Mrs. Gibbons, Mr. H. Winterton (Senior Vice-President of the Institute) and Mrs. Winterton, Mr. C. W. Bigg (Junior Vice-President of the Institute) and Mrs. Bigg, Mr. Barrington Hooper, C.B.E., Mr. and Mrs. C. K. Everitt, Mr. and Mrs. Joseph Ward, many Past Presidents of the Institute, and Mr. J. G. Pearce (Director, British Cast Iron Research Association).

The Toasts

MR. H. WINTERTON (Senior Vice-President) proposed "The City and Trade of Sheffield." Some of the city's products, he said, were in universal daily use, and possibly some people looked upon the city as being merely utilitarian. It was true that Sheffield was pre-eminently an industrial centre. It had been satisfactory to hear at the Conference that, after a period of comparative quietude, Sheffield had once more become a busy hive of industry. But not only was Sheffield a city of modern repute; it had also a very interesting history. Among the many interesting developments which had originated in Sheffield, Mr. Winterton mentioned its introduction of cast steel in 1740, and the subsequent advancement in connection with steel from that time until the present era of stainless steel and other modern inventions. Sheffield was not only in the forefront in regard to steel, however; many of the leading ironfounders of the district bore household names, names to be conjured with in the commerce of the universe.

One of the latest, and possibly most impressive, examples of the advancement effected in Sheffield was the establishment recently of the Degree Course in Founding at Sheffield University. That was a matter for sincere congratulation, bearing in mind that Sheffield University had in the past done wonderful work and had sent engineering experts to all parts of the world.

Mr. Winterton coupled with the toast the name of the Lord Mayor, and paid a tribute to him in respect of his great public work as well as for the valuable support he had given to the Conference.

Sheffield's Industrial Development

The LORD MAYOR OF SHEFFIELD, responding, said that although at one time Sheffield was perhaps referred to as a little village on the River Don in Yorkshire, and although he had had heard it said in the South of England that Sheffield was of such little importance that it need not be mentioned at all in any itinerary of the country, at all events those resident in the City, and who counted themselves fortunate to be resident there, believed that Sheffield held a premier position among the great cities of their beloved country. He ventured to point out that Sheffield was the largest city in the largest county in the country, the beautiful "county of broad acres," and also that Sheffield was the fifth city in England from the point of view of size—and, he ventured to say, it was not below the fifth in importance. Indeed, he would put it higher than that. Further, Sheffield took pride in what it had done, and still continued to do, in regard to national trade recovery, and not the least interesting factor in that recovery was the wonderful system of co-operation which existed in Sheffield between the leaders of industry, the great University and the Technical College. It was proud of the wonderful research work carried out there during the past quarter of a century; industry used the research laboratories of the University, and that co-operation had been to their mutual advantage. Another development in which he took pride was the establishment at the University of the Foundry Degree Course within the Faculty of Metallurgy. This University, which he ventured to suggest was the premier in the country, had not the *éclat* of the older Universities; but it was because of its youthfulness and its determination to find a place in the sun that its work was so beneficial to the community.

After a jocular reference to the fact that Mr. Winterton (who on civic occasions was known as Bailie Winterton), although a "mere Englishman," had managed to capture an important position in the heart of Scotland, the Lord Mayor added that Sheffield esteemed it a great honour that the Institute of British Foundrymen had met in the City that week. He again extended to the members a hearty welcome and hoped that when they left Sheffield they would carry with them the knowledge that the time spent there had been spent profitably.

The Lord Mayor, on behalf of the Sheffield Council, asked each of the ladies to accept a "pay envelope." Each envelope contained a handkerchief attractively coloured and decorated, being an example of the beautiful work turned out by the disabled soldiers at the Painted Fabrics Factory in Sheffield. In the post-war years, said the Lord Mayor, it had been one of the proud features of the City's life that it had done everything humanly possible to help those who had suffered on behalf of the country during the Great War. There was nothing of which Sheffield citizens were more proud than the work carried on at the factory by the disabled soldiers.

"Science Hand in Hand with Labour"

SIR H. C. HAROLD CARPENTER, F.R.S. (President, Iron and Steel Institute), proposed "The Institute of British Foundrymen." Although, he said, the Institute was little more than thirty years old, the industry it represented extended back to the very beginnings of civilisation; indeed, its beginnings were lost in the mists of time, and it could be said with truth that every branch of industry to-day had resulted from the original discovery of prehistoric man—one of the greatest discoveries ever made—that it was possible to prepare a metal from a stone. When prehistoric man had done that and had worked out methods of founding, he had laid the foundations of everything they inherited to-day. Had that discovery not been made, there would have been no metallurgy to-day, and the face of the earth would have been quite different. Naturally, the development of metallurgy to its present stage had occupied a long time. The blast furnace, which was one of the founder's most important instruments of production, had needed about 2,500 years in which to mature. It was the most important instrument of production of the steel industry, on which the prosperity of Sheffield rested as much as it did on a plentiful supply of cheap iron. Apparently they did not realise fully to-day the enormous development made in the production of metals. Quite recently he had been interested to learn that more metal had been produced in this century than during the whole of the previous history of the world. That was a very remarkable fact.

The Institute's motto—"Science hand in hand with labour"—was very appropriate, because much of what was called "science" to-day had developed because of man's long and intense struggle with the properties of metals. The working out of their wonderful properties had been a very slow business; but the reasoning qualities of man had been developed in that way. After all, there had been introduced into our language various phrases which were based

on the properties of these wonderful materials; for example, the common phrases "as strong as iron" and "as true as steel," indicated that these qualities of metals had come to stand as standards of our conduct. If there were other substances which merited such a record he had yet to hear of them.

Commenting upon the Lord Mayor's reference to the remarkable phenomenon that Mr. Winterton, as an Englishman, had attained a post in Scotland, Sir Harold said that was not a unique instance, because Prof. Andrew (Professor of Metallurgy, Sheffield University), provided another example; although an Englishman, he had for many years held the post of Professor of Metallurgy at the Royal Technical College, Glasgow. Sir Harold said he hoped he would not be regarded as untactful if he pointed out also that Prof. Andrew was a product of Lancashire metallurgy. He had been Sir Harold's first and most precious student at the Manchester University 29 years ago. He also mentioned his early association with Mr. J. W. Gardom (the Convener of the Institute's Technical Committee); just as Prof. Andrew had been Sir Harold's first student at the University of Manchester, so Mr. Gardom had been his first laboratory assistant. Sir Harold emphasised the importance of Mr. Gardom's services by saying that if he personally were absent from the department, the work went on very nicely; if his demonstrator were absent, things did not go quite so well; but if Mr. Gardom were away, the whole place broke down. It was a matter of very great delight to Sir Harold that two of that little band who had gathered in the very humble cellars of the University of Manchester had attained positions of such eminence and usefulness in the Institute.

THE TOP TABLE AT THE ANNUAL BANQUET.

(Left to right): The Master Cutler of Sheffield (Mr. Alexander Williamson); Mrs. J. E. Hurst; The Lord Mayor of Sheffield (Ald. P. J. M. Turner); Mr. J. E. Hurst (President); The Lady Mayoress of Sheffield (Mrs. Turner); Sir H. C. Harold Carpenter, F.R.S.; Mrs. A. B. Winder; Commander Sir Charles W. Craven, O.B.E., R.N.; Mr. Joseph Ward, J.P.

Associating with the toast the name of Mr. Hurst, the President of the Institute, Sir Harold said he had had the privilege of his acquaintance for about 16 years. Mr. Hurst's name was very much identified with modern scientific work in connection with founding, and his work was known far beyond the limits of the Institute. One could not express the quality of his work better than by saying that it was widely known wherever founding was scientifically studied. Sir Harold had found Mr. Hurst's book on "The Metallurgy of Cast Iron" to be one of the very best books on the subject, and he paid a tribute to Mr. Hurst for having written it, so placing his knowledge at the disposal of his fellows.

The toast was received with musical honours.

The President's Reply

The PRESIDENT, responding, expressed the Institute's appreciation of the honour Sir Harold had done them in proposing the toast and his own personal thanks for the remarks made concerning himself. Naturally, he said, all the members were proud of the Institute, and all who had watched its growth during the past years were more than delighted that a man of such outstanding eminence in the world of metallurgical science as Sir Harold Carpenter had found it possible to honour it in this manner. Whilst they all knew Sir Harold in his various metallurgical capacities, they knew him also as an honorary member of the Institute. They were proud of that, as they were also of the fact that his investigations were at one time concerned with cast iron, a material in which the Institute was so profoundly interested. The President held the view that the metallurgy of cast iron was rapidly becoming so vast that it demanded recognition as a distinct and separate section within the broader field of metallurgy; and Sir Harold's most exhaustive and comprehensive work on the growth of cast iron had laid the foundation of a very large section of the science of the metallurgy of cast iron. He ventured to think that that view was supported by a large number of the members of the Institute. His friend Dr. Hatfield had on one occasion suggested to him that cast iron metallurgists were opportunists. Whether or not Dr. Hatfield had made that remark jocularly the President was not sure, but he believed it was quite true, and it could be accepted as evidence of their vitality and their determination to further the development of this material amongst all those rapid developments which were taking place in metals and alloys to-day.

The intimate desire of all the members was to see the Institute expand and take its full place amongst the leading metallurgical scientific bodies throughout the world. This led him to a thought which he was anxious to take this opportunity to express. It was that, in his opinion, the continued development of the Institute could be served best by adding to its activities and associations all those things which added to its dignity and prestige. Associations such as it had formed already with the British Cast Iron Research Association, with the Sheffield University, through the new Foundry Degree Course within the Faculty of Metallurgy, and with the new British Foundry School, which had been formed in Birmingham, were typical. If the direction of the Institute were concentrated on those lines he was certain that it would be to its benefit and to the gratification of its very exacting treasurer, Mr. W. B. Lake.

The President took the opportunity to express his personal thanks to all the officers of the Sheffield Branch for their unstinted help and work in the organisation of the Conference. None of them would object to his singling out the names of the Hon. Convention Secretary, Mr. T. R. Walker, and also that of the Branch-President, Mr. A. Whiteley. The President also thanked the Institute's General Secretary, Mr. T. Makemson, for his kindly help and assistance, and also Mr. Roy Stubbs, the immediate Past-President, for his energy and determination. Mr. Makemson had made a good many visits to the organising meetings in order to give the benefit of his advice and help, and he had travelled from Manchester on each occasion to do so.

Finally, the President expressed his personal gratitude to his colleagues and the directors of the two companies with which he was associated, *i.e.*, Messrs. Bradley & Foster, Limited, and Messrs. Sheepbridge Stokes Centrifugal Castings Company, Limited, for without their assistance and forbearance in matters which ought to have been done and matters which ought not to have been done, he could not imagine how he could have undertaken the duties of the Presidency.

The Visitors

MR. ARTHUR WHITELEY (President, Sheffield Branch of the Institute) proposed the toast of "Our Guests," and expressed his great pleasure and pride in the fact that, as a very junior officer of the Institute (scarcely a day old, as a matter of fact), he was entrusted with this very agreeable duty.

The Institute of British Foundrymen was, of course, a very serious and learned society, not given to excessive frivolity or jollity, but once a year it gave a party to which were bidden all the members and their consorts and also a chosen few guests whom the members delighted to honour. His toast, therefore, was to the chosen few, those ladies and gentlemen who were present as the official guests of the Institute. He assured them that the Institute appreciated the fact that they had been able to come to the party, and hoped sincerely that they would enjoy themselves. He took the opportunity to extend a special welcome to the Lord Mayor and Lady Mayoress of Sheffield. The members of the Institute were particularly glad to have this opportunity of acknowledging in a small way their gratitude to the Lord Mayor and Lady Mayoress for the generous hospitality and entertainment they had afforded at the Town Hall on the previous evening. They were proud, too, that the Master Cutler had honoured them that evening. They were delighted to have him on that occasion; surely this was one of the very few banquets he had attended where he was not expected to make a speech. They all trusted that he was enjoying a unique holiday. Mr. Whiteley also extended a very hearty welcome to Sir Harold Carpenter. They were indeed very grateful to him for honouring the Institute with his presence that evening, and thanked him sincerely for having proposed the toast of "The Institute" in so charming a manner.

Other guests whom he mentioned particularly were Mr. A. K. Wilson, President of the Sheffield Chamber of Commerce, and Mrs. Wilson; Mr. W. M. Gibbons, Registrar of the University, and Mrs. Gibbons; the Mayor and Mayoress of the neighbouring town of Chesterfield; the Town Clerk of Sheffield and Mrs. Gibson; also many leading industrialists—Commander Sir Charles

Craven; Mr. and Mrs. Winder; Mr. and Mrs. A. J. Grant; Mr. and Mrs. C. K. Everitt; Mr. and Mrs. Joseph Ward and many others, and also other gentlemen representing kindred and allied associations, such as Mr. J. G. Pearce, Director of the British Cast Iron Research Association, and Mr. F. M. Fisher, President of the Refractories Association of Great Britain; and they must not forget, of course, their friends who represented the daily and technical Press.

There were two gentlemen to whom he referred specially, namely, Mr. T. R. Walker, the Conference Secretary, and their well-tried and trusted Branch Secretary, and also Mr. Tom Makemson. They were very grateful indeed to both for their wonderful work. On their shoulders had fallen the great bulk of the work in the organising of the Conference, and Mr. Whiteley said he was sure that the President would wish him publicly to express gratitude to these gentlemen.

He had great pleasure in coupling with the toast the name of Mr. P. B. Henshaw, a gentleman well known in the locality, whom they were always delighted to meet. Mr. Henshaw was a man of many parts: joint managing director of one of the large steelworks, a graduate of the University, a keen sportsman and a born orator and after-dinner speaker. In asking him to respond to the toast it was realised that he was not a foundryman, and therefore could not presume to criticise, and it was felt that with his accomplishments and attainments he would be able to respond adequately for all the various interests represented by their many guests and their ladies.

Renewing his welcome to all the guests, he expressed the hope that they would be able to enter in their diaries for that day a similar note to that entered by the immortal diarist, Samuel Pepys, under the date of July 19, 1668: "A good dinner and company that pleased me mightily."

MR. P. B. HENSHAW made a jocular reference, in his response, to George Washington, who, he said, would have felt difficulty in expounding the marvels of his castings, knowing that there were such things as blowholes and non-metallic inclusions (which never existed in any castings made by any member of the Institute of British Foundrymen!). But one could be perfectly certain that if George Washington were responding to this toast he would have been able to say with perfect sincerity that this occasion had afforded great pleasure to everyone of the guests present that evening.

On behalf of the guests, Mr. Henshaw congratulated Mr. Hurst on having attained the high office of President, which they knew he would occupy with satisfaction. His energy, his capability and that pleasant manner of his had endeared him to all his colleagues in the Sheffield district and, one was perfectly certain, to all members of the Institute. The guests would like to congratulate both Mr. Hurst and the Institute on Mr. Hurst's election and to wish them all a very happy and successful year.

He also took the opportunity to compliment the Sheffield Branch upon having secured as its President a man so energetic as Mr. Whiteley, whose capabilities also had been well proved. The guests were very happy in the knowledge that, as Mr. Whiteley had stated, they were chosen guests, chosen to meet the members of the Institute, and to enjoy with them a very happy evening. He expressed on behalf of the ladies also their appreciation of the fact that each of them had been presented with a gift, particularly as it represented an example of the work of the Disabled Soldiers. Altogether, they were enjoying a very happy evening, and they thanked the Institute for the courtesy extended to them.

Presentation to Mr. Walker

MR. JOHN R. HYDE expressed thanks on behalf of the Council of the Sheffield Branch of the Institute to Mr. T. R. Walker for his great services as hon. convention secretary and secretary of the Sheffield Branch, and presented to him, also on behalf of the Branch, a four-piece silver tea service as a mark of appreciation of those services. Mr. Walker's work, he said, was very highly appreciated, and it was felt that this banquet would provide a very suitable occasion to make a presentation to him. The present took the form of some old Sheffield plate. Inasmuch as Mr. Walker was very interested in developing and improving the craftsmanship of Sheffield, it was fitting that the Branch should present him with some old Sheffield plate which would always serve as a reminder of his connection with the high standard of craftsmanship of the City. The presentation comprised four pieces, and it was hoped that they would serve always to remind him also of his very happy connection with the Sheffield Branch of the Institute, as well as affording some recompense for the very hard work he had put in on behalf of the Branch.

MR. WALKER, expressing his thanks for the kindly thought which had prompted the gift, assured the members that the work of organising the Conference had been extremely pleasing, and it had been rendered all the more pleasing by the kindness of the firms in the Sheffield district who had been so very generous in their support. It was a sign of the times that they were so ready to help the Institute.

During the evening music was provided by Victor Haythorne and his orchestra. There was also very amusing entertainment by the renowned "Stainless Stephen," who made some very apt comments on the alleged activities of some of those present, and a cabaret was arranged by Mrs. Amy Twigg.

Thursday's Works Visits and Reception

On Thursday afternoon, July 4, parties of members visited the following works:—The Grimesthorpe and Vickers works of the English Steel Corporation, Limited; Newton Chambers & Company, Limited; General Refractories, Limited, Worksop, and the research laboratories and high-frequency induction furnaces of the United Steel Companies at Stocksbridge. Visits were also arranged for the ladies, a large number of whom inspected the manufacture of fancy goods by disabled soldiers and sailors at the workshop of Painted Fabrics, Limited. Another party studied the making of biscuits by Messrs. W. Gunstone & Sons, Limited, and a small group spent a very interesting afternoon at the printing works of the "Sheffield Telegraph."

On Thursday evening members and ladies were entertained at a very charming social function at the Western Bank Buildings of the University. The guests were received by Colonel H. K. Stephenson, D.S.O., the Pro-Chancellor, the Vice-Chancellor, Dr. A. W. Pickard-Cambridge, and Mrs. Pickard-Cambridge. The beautiful Firth Hall was available for dancing and the guests inspected various parts of the building, considerable interest being shown in the library, which contains many valuable first editions. Refreshments were provided in the University refectory.

The Institute is indebted to the University of Sheffield for many courtesies and considerable assistance in connection with the Conference arrangements, but all who were present felt that the hospitality of the University reached its highest level in the very delightful entertainment which was accorded to the visitors.

The Garden Party at Hope

Members and ladies were able to enjoy some very beautiful scenery in the course of an excursion which took place on Friday, July 5. The party travelled by motor coach along the Derwent reservoirs via Ashopton, in the valley of the Derwent. A considerable portion of this valley will soon be submerged, as very shortly the construction of an additional reservoir will be commenced. Returning down the Derwent valley, lunch was served at the Marquis of Granby Hotel, Bamford. After lunch the drive was resumed through the village of Castleton to a point beyond the village commanding a wonderful view of the beautiful Hope Valley. At the Rising Sun Hotel, at Hope, the party were the guests of the President and Mrs. Hurst at a garden party. Chief among the attractions was the open-air swimming bath.

After tea, Mr. H. Winterton, Senior Vice-President, voiced the thanks of the party to Mr. and Mrs. Hurst for their hospitality, and also took an opportunity of expressing the thanks of all the members and ladies to the Sheffield Branch for the extraordinarily successful arrangements they had made for the Conference. He particularly stressed the debt which the party owed to Mr. T. R. Walker, the honorary

BY THE SWIMMING POOL AT HOPE.

Standing (left to right): Mr. Lockwood, Mr. Stobie, Mrs. Lockwood, Mrs. Bigg, Dr. Everest. Seated: Mrs. Delport, Mrs. Gardom, Mrs. Stubbs, Mrs. Stobie, Mrs. Everest and Mrs. Norman Cook.

conference secretary, for the indefatigable work he had carried out over many months, and congratulated Mr. Walker upon the success of the organisation. Mr. Winterton's remarks were supported by Mr. Bigg, the Junior Vice- President. Mr. Hurst replied on behalf of Mrs. Hurst and himself, and Mr. Whiteley, President of the Sheffield Branch, and Mr. Walker responded on behalf of the Branch. Mr. James Smith then proposed the toast of "The Ladies," to which Mrs. Hurst replied in a charming little speech.

After tea the party returned to Sheffield and the dispersal to their various homes commenced; thus ended a very successful and happy Conference.

LIST OF MEMBERS ATTENDING THE SHEFFIELD CONFERENCE

J. Affleck, Clarkston; J. B. Allen, Chesterfield; G. B. Allwood, Derby; D. Anderson, Middlesbrough; Prof. J. H. Andrew, Sheffield; Major J. W. Athey, Birmingham; J. A. Ayres, Sheffield; P. T. Bailey, Dronfield; I. H. Baker, Wolverhampton; R. Ballantine, Glasgow; S. Barraclough, Sheffield; A. S. Beech, Leighton Buzzard; James Bell, Sutton Coldfield; W. E. Benbow, London; C. W. Bigg (Junior Vice-President), Derby; Major T. G. Bird, Gateshead; J. Blakiston, Middlesbrough; E. M. Boote, Coventry; H. Bradley, Bolton; J. H. D. Bradshaw, Wednesbury; W. Brindle, Doncaster; G. E. Brown, Birmingham; E. J. Brown, Sheffield; W. Brown, Sheffield; W. Brown, Chadderton; H. Bunting, Derby; K. M. Burder, Loughborough; C. J. Burgess, Banbury; F. G. Butters, Uttoxeter; G. M. Callaghan, Birmingham; J. Cameron (Past-President), Kirkintilloch; A. Campion, Glasgow; A. Carr, Sheffield; G. C. Castle, Birmingham; R. Causebrooke, Ilford; H. F. Coggon, Halifax; B. L. Collins, Sheffield; F. J. Cook (Past-President), Birmingham; W. N. Cook, Manchester; J. H. Cooper, Darlington; E. J. Crawley, Sheffield; F. J. Cree, Rochester.

C. J. Dadswell, Sheffield; J. Davenport, Preston; C. D. Davy, Barnsley; S. E. Dawson, Beeston; V. Delport, London; W. E. Dobson, London; Dr. J. W. Donaldson, Greenock; J. F. Driver, Loughborough; J. Durrans, Penistone; P. H. Durrans, Penistone; E. B. Ellis, Monkseaton; J. Emmott, Dronfield; Dr. A. B. Everest, London; P. C. Fassotte, Brussels, Belgium; V. C. Faulkner (Past-President), London; H. V. Fell, Sheffield; A. Firth, Sheffield; T. C. Firth, Sheffield; B. S. Fletcher, Wolverhampton; E. Flower, Manchester; C. Fontaine, Newport; H. Forrest, Stanningley; G. E. France, Halifax; T. H. Gameson, Birmingham; J. W. Gardom, Birmingham; W. A. Geisler, Frankfurt, Germany; V. A. Goddard, Dronfield Woodhouse; J. T. Goodwin (Past-President), Chesterfield; T. Goodwin, Borrowash; J. G. Gould, Norton-on-Tees; E. C. S. Greaves, Pontefract; P. Green, Sheffield; J. Gregory, Sheffield; G. Griffiths, Birmingham; W. T. Griffiths, London; D. Guthrie, Eaglescliffe.

S. Hadfield, Sutton Coldfield; G. L. Harbach, Newark; A. Harley (Past-President), Coventry; F. A. Harper, Manchester; A. J. A. Harris, Doncaster; Dr. W. H. Hatfield, Sheffield; F. J. Hemming, Walsall; H. Hinchliffe, Sheffield; A. J. Hinton, Oldham; B. Hird, Newport; J. Hird, Birmingham; S. A. Horton, Derby; J. Hogg, Burnley; W. Holland, Manchester; L. Holt, London; Barrington Hooper, London; E. J. L. Howard, Manchester; F. Hudson, Kilmarnock; A. Hunt, Chesterfield; Dr. L. B. Hunt, London; J. E. Hurst (President), Lichfield; J. R. Hyde, Sheffield; A. E. Jackson, Stockton Brook; J. Jackson, Accrington; J. K. Jackson, Ilkeston; J. C. Jones, Workington; R. A. Jones, Manchester; H. S. Joynes, Long Eaton; C. H. Kain, Braintree; G. E. King, London; H. E. King, Nottingham; R. A. Kirkby, Sheffield; W. T. Kitching, Sheffield; W. B. Lake (hon. treasurer), Braintree; Sir W. J. Larke, London; W. T. Laverton, Stoke-on-Trent; S. Leetch, Rotherham; J. E. O. Little, Bessacar; F. N. Lloyd, Wolverhampton; H. W. Lockwood, London; Dr. Loeb, U.S.A.; A. Lomas, Sheffield; Dr. P. Longmuir, Sheffield; E. S. Lord, Rochdale; J. Lucas, Loughborough; G. T. Lunt, Wolverhampton.

W. Machin, Barrow-in-Furness; T. Makemson (secretary), Manchester; R. A. Martin, London; J. Masters, Shrewsbury; W. H. Meadowcroft, Burnley; J. E. Mercer, Hartburn; T. R. Middleton, Sheffield; R. A. Miles, Manchester; H. Mills, Manchester; W. T. Mitchell, Stirling; D. M. Moir, Birmingham; G. E. Morgan, Cardiff; W. J. Molineux, Wolverhampton; J. McArthur, Motherwell; J. J. McClelland, Bilston; M. Nelson, Sheffield; F. D. McGrah, Wolverhampton; J. McLachlan, Manchester; N. McManus, Giffnock; G. Offiler, Sheffield; M. C. Oldham, Barrow; W. O'Keefe, Birmingham; I. S. Osborn, Sheffield; C. A. Otto, Manchester; S. Owen, Liverpool; G. L. Oxley, Sheffield; T. A. Oxley, Sheffield; W. Parker, Bradford; F. C. Pearce, Coventry; J. G. Pearce, Birmingham; J. H. Pearce, Sheffield; A. Phillips, Manchester; H. Phillips, Wednesbury; R. Pipes, Ealing; C. D. Pollard, Scunthorpe; H. F. Poole, Keighley; A. A. Prescott, Stockport; J. S. G. Primrose, Manchester; T. F. Procter, Glasgow; W. Pyatt, Leicester; J. G. Rees, Stocksbridge; W. J. Rees, Sheffield; J. A. Reynolds, Prescot; N. D. Ridsdale, Middlesbrough; N. W. Riley, Harrogate; H. Roberts, Leeds; H. B. Roberts, Prescot; J. E. Roberts, Sheffield; W. Robertson, Glasgow; F. W. Robinson, Sheffield; A. Roebuck, Sheffield; A. Roger, Lymm; W. F. Rowden, Warrington; F. W. Rowe, Huddersfield; J. Roxburgh, Sheffield; F. S. Russell, Sheffield; P. A. Russell, Leicester.

A. Scholes, Middlesbrough; W. Scott, Monkseaton; A. E. Scrayfield, Sheffield; W. L. Selkirk, Birmingham; G. Senior, Sheffield; D. Sharpe, Glasgow; J. Shaw, Southsea; H. Shillitoe, London; F. A. Shirt, Sheffield; A. J. Shore, Birmingham; A. Smith, Bolton; James Smith, South Shields; W. H. Smith, Birmingham; J. K. Smithson, Stockton-on-Tees; R. Spriggs, Loughborough; R. W. Stainton, Kendal; A. L. Steggles, Sheffield; F. E. Steele, Sheffield; J. F. Stanier, Sutton Coldfield; Victor Stobie (Past-President), Harrogate; Roy Stubbs (Immediate Past-President), Manchester; G. C. Studley, Timperley; A. Sutcliffe, Bolton; Dr. T. Swinden, Sheffield; H. Taft, Smethwick; E. A. Tait, Low Fell; P. Talbot, Erith; G. B. R. Taverner, London; M. D. Thompson, Aldridge; T. E. Thompson, Rochdale; A. G. Thomson, Sheffield; J. A. Thornton, Manchester; A. Timmins, Birmingham; A. Tipper, Birmingham; C. W. D. Townsend, Brigg; H. Townsend, Sheffield; R. C. Tucker, Chapeltown; A. C. Turner, London; Prof. T. Turner, Leatherhead; T. H. Turner, Doncaster; T. R. Twigger, Coventry; T. Turvey, Sheffield; E. V. Upton, Sheffield; J. L. F. Vogel, Sheffield.

A. W. Walker, Huddersfield; T. R. Walker (honorary Conference Secretary), Oughtibridge; J. Wallis, Ambergate; F. J. Wares, Peterborough; O. H. Wass, Sheffield; T. Watson, Sheffield; J. A. E. Wells, Sheffield; W. West, Leyland; J. T. Wharmby, Stockport; E. Wharton, Chesterfield; H. Wharton, Sheffield; A. Whiteley, Sheffield; T. Wilkinson, Stockton-on-Tees; L. P. Wilks, Birmingham; C. E. Williams (Past-President), Cardiff; G. Williams, Birmingham; W. Williams, Cardiff; P. H. Wilson, Nottingham; R. Wilson, Wednesbury; W. R. Wilson, Liverpool; H. Winterton (Senior Vice-President), Milngavie; H. T. Winterton, Chesterfield; D. H. Wood, Birmingham; J. F. Wood, Wellingborough; A. S. Worcester, Huddersfield; J. G. Wrightson, Thornaby.

Oxygenation of Blast

In a recent issue of "Stahl und Eisen," W. LENNINGS describes research on the enrichment of the blast in blast furnaces with oxygen, a method which increases the heat available for reaction at the maximum reaction temperature, the coke consumption remaining unaltered. It has been found that for a given heat requirement oxygen-enrichment of the blast reduces the coke consumption, as well as enables the blast supply to the furnace to be diminished. The throat temperature and the heat loss at the throat also drop, while the total heat input of the furnace is reduced by the heat content of the diminished hot-blast supply. In the maximum temperature region of the furnace, enrichment of the blast increases the difference in temperature between the gas and the charge and hence augments the velocity of smelting.

Experiments on blast enrichment were carried out by the author with an experimental furnace of 50 to 60 tons daily output, and showed that in the manufacture of basic-Bessemer, steel-making, spiegel and foundry irons which require 1,000 to 1,150 kg. of coke per ton of iron made, about 100 to 150 kg. of coke per ton of iron can be saved using an enriched blast at a temperature between 700 and 800 deg. With other grades of iron, such as ferro-manganese, requiring a higher coke consumption, as much as 300 to 400 kg. of coke was saved per ton of iron made. Furnace linings and cooling arrangements were found to be no more affected by using an oxygenated blast than with an air blast, even with highly-basic slags.

The extent to which the blast can be enriched with oxygen is, however, limited, firstly by the coke consumption, and, secondly, by the furnace gas temperature. In general, oxygenation may be taken to 24 to 26 per cent., and with ferro-manganese to 30 per cent.; beyond these limits the excess of oxygen is likely to cause a shortage of heat in the shaft. Enrichment is found the more advantageous the higher the throat temperature of the furnace and the higher the coke consumption. The process is not suitable for low blast-furnace-gas temperatures, as when smelting minette.

In the manufacture of basic-Bessemer iron, where the coke consumption is relatively small, oxygenation of the blast is limited to special cases. Where the stoving of the blast is expensive, oxygenation will eliminate part of the pre-heating and reduce the cost of smelting. If a furnace runs slowly and has a tendency to scaffold, oxygenation of the blast will accelerate the smelting reactions. The higher hearth temperatures attained by blast oxygenation enable a more extensive reduction of the silica to be obtained with low coke consumption. Further, more limey slags can be smelted than when working with ordinary air. As a result the manganese content of the slags may be considerably reduced.

Oxygenation also permits the output of a furnace to be raised without increasing the load on the furnace. The tests which were made with a variety of ores and ore mixtures showed, moreover, that enrichment of the blast does not modify the quality of the iron produced, except in so far as concerned the small sulphur content of the iron. Discussing the economics of the process, the author points out that this factor depends essentially on the local conditions. Its application is naturally most suitable where oxygen can be manufactured cheaply, and also where coke prices are low. Based on prices in the Ruhr district and making high-silicon pig-iron, the saving effected in the trial campaigns was about 1 to 1.50 Rmk. of coke per ton of iron made, taking oxygen at 7 Rmk. per 1,000 cub. m. at N.T.P. and of 80 per cent. purity. A further saving may accrue from the increased output of manganese and the greater output from the furnace. The process is also economic for making ferro-manganese.

XUM

Strickle Moulding of Large Castings*

By H. FABRE (Managing Director) and H. DUBOIS (Foundry Manager) of the Etablissements Bracq-Laurent, at Achicourt (Pas-de-Calais)

[FRENCH EXCHANGE PAPER]

Introductory

The authors desire to express their thanks to the Institute of British Foundrymen for the honour it has done them in inviting them to contribute a Paper, and apologise for presenting a subject which has already been dealt with so often, a subject, however, which has the particular property of never being exhausted. Apart from the risks which attract every man of action, loam moulding leaves a great deal to the initiative of the individual. Every problem involved therein carries a certain number of solutions, all of which arise out of a series of laws derived from experience. It is this accumulation of practical data which the authors propose to present and the interest shown will be an ample reward.

Definitions and General Applications

It is not presumed to teach the meaning of strickle moulding, but rather to present a general idea of its numerous applications. There are cases, such as that of complicated castings, where the strickling of certain portions of the mould is imperative owing to reasons to be disclosed later. Alongside these portions are placed such parts of the mould as constitute the form of the casting incapable of being strickled, giving a happy combination of both strickle and pattern moulding.

In loam moulding and where several castings of the same kind are required, this method of moulding permits of re-using the brickwork, whilst pattern moulding would, in the case of each casting, have necessitated the complete demolition of the mould before each fresh moulding operation. Strickle moulding, from whatever standpoint it may be viewed, affords the great advantage of considerably reducing patternmaking costs, this advantage being emphasised with the reduction of the number of castings to be made.

The chief disadvantage of strickle moulding is that it requires specially skilled men and careful work, particularly in respect to initial preparation, which is a more exacting and precise operation than in pattern moulding. During the actual moulding the operator has frequently to check various data in order to avoid any distortion of the mould, and so to obviate the errors in calculation to which such distortion would give rise when assembling the mould.

In certain cases this method of moulding necessitates the provision of special tackle, but the total cost incurred in patternmaking for this purpose is invariably less than the cost of a full pattern. Finally, in the majority of cases strickle moulding takes longer than pattern moulding.

The examples to be given have been selected to illustrate in some measure the principal classes of work to which strickle moulding may be applied. This Paper being addressed to experienced foundrymen, it is proposed to outline the chief characteristics of each type of job without dwelling upon the details of manufacture with which every foundryman should be familiar.

MR. H. FABRE.

MR. H. DUBOIS.

When Should this Method be Used?

Its application is determined by economic considerations connected with patternmaking or, more rarely, with moulding. It should be adopted in nearly all cases where large plain castings of circular sections or castings in which the main portion is a circular solid are concerned. Where loam is selected as material, it will be advantageous when strickling to obtain a set of castings, so that the provision of special tackle is made worth while. But in this case, just as in every other, there is no absolute rule; only the profound study of all the data connected with the problem can, when all is said and done, determine the course to be adopted.

Materials

Strickle moulding may be effected either in sand or in loam. The two crafts are, as is well known, quite different. For instance, in the case of sand, there is only one strickle board, in two parts, the equipment used is normal, and the operations are consecutive. As regards loam moulding, however, two different boards are necessary, the two portions of the mould are separated, the equipment is a special one, and the operations can be carried out simultaneously.

Patternmaking

The patternmaking equipment is very simple. As regards sand moulding, it comprises:—(*a*) The "matrix board," serving to obtain the false pattern in sand which permits the ramming of the top portion, and (*b*) the "claw" for hollowing out the lateral and lower shapes of the casting.

In loam moulding, the two portions of the mould being formed independently of each other, two distinct boards have to be provided: one for the upper portion, the other for the body and the bottom portion.

More details of the question of patternmaking will be given in each of the special cases to be considered.

Equipment

The tackle should be of sound construction and be maintained in good condition. It comprises the ordinary moulding tools (circular and vertical, circular and horizontal, rectilineal or curvilineal) and special moulding tools (loam-moulders' horse, eccentric spindle, double sockets, profiling and balanced spindles, threaded shaft, flat strickling). It is not proposed to enter into a detailed description of each of these tools here, but their application will be described in the following sections.

Plain Castings of Circular Section ("Blackpot," weight 12 tons)

Vertical Strickle Moulding.—This is a plain vat, but one of large dimensions (height 3.05 m., external dia. 2.81 m.).

Selection of Material.—In selecting the material to be employed, the management is guided by considerations of production costs and facility of execution. In the case of sand moulding one must first consider the use of a large number of moulding boxes of large dimensions, which are, therefore, heavy, cumbersome and very costly. For a casting of this size, the loam mould is more stable than the sand mould, so that its disintegration is less to be feared. The strength of the mould being very great, it is possible to walk in it. This greatly facilitates the operations of assembling or repairing the moulds. If any differences in their thickness are

* A Paper read before the Annual Conference of the Institute of British Foundrymen at Sheffield, July 2 to 5, 1935.

found when assembling, it is very easy to scrape away or to add loam to the sides as required, so that success is more certain owing to the greater stability of the mould. A further and more important advantage is the possibility of re-using nearly the whole of the brickwork in cases where several castings are to be made. Loam moulding should therefore be used.

Patternmaking.—The making of the pattern is very simple. The board A, Fig. 1, serves to strickle the body of the casting. The bottom of the core is strickled, upside down, with the board C and comes to rest on a false portion of the same shape obtained by means of the board B; the top outside rib is represented by the part D, the flange of which is removable on the outside.

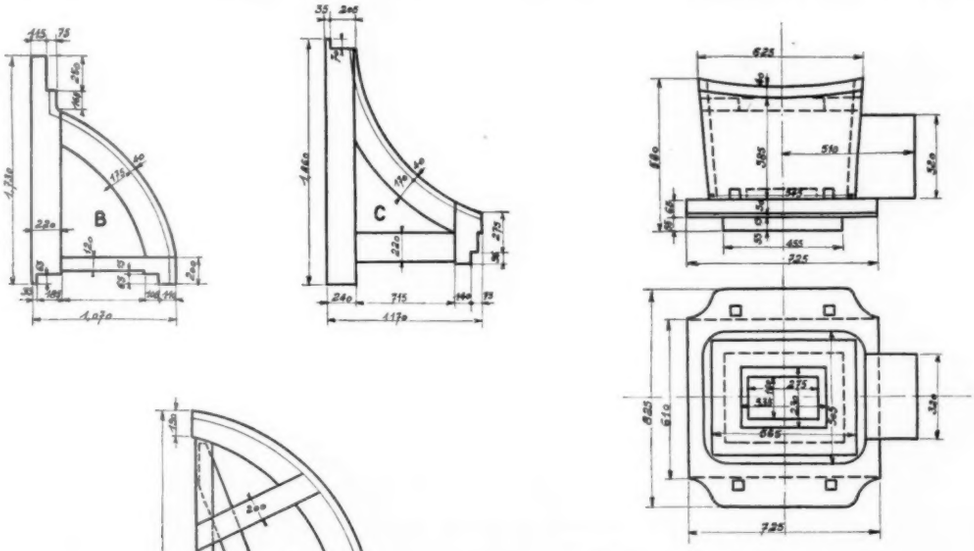


FIG. 1.—TACKLE REQUIRED FOR MOULDING A BLACKPOT.

Tackle.—The strickling tools do not differ from those used in sand moulding. They comprise a spindle and a socket. The equipment should include a circular plate A upon which the bottom of the mould (Fig. 2) is built up. This plate must rest firmly on the anchorage. The covering plate B carries four lifting lugs on the outside and six lugs inside to enable the core to be fixed. Plates C, D, E are core plates; plate C carries six countersunk eyes corresponding to the six internal lugs of the covering plate. The latter should not hinder the withdrawal of the casting after pouring. They should leave a sufficiently large margin to permit of their being surrounded by a packing of straw, coke breeze and loam brick. Thus, opposite the grid there is obtained a portion of the mould which will not be too hard: this is very important. Fig. 3 illustrates the precautions to be taken for this purpose.

Moulding Details—(*a*) *Building the Body.*—The bottom of the pit must be very hard, so as to withstand the pressures imposed on the bed plate during the casting. The building up of the body is effected in two operations, because the bottom cannot be dried *in situ* and has to remain about 24 hrs. in the stove. Immediately the bottom is dry, the brickwork is continued up to the joint by means of the strickle board, being subsequently dried from the outside by a coke fire.

When the bricks are dry, the hard loam is rammed flat and the mould roughed-out. Finishing is done by ramming the soft loam and strickling, after which the final drying is effected by portable coke fires. All roughnesses in the mould are removed with a scraper, while finishing consists in rubbing the walls of the mould with a damp rag, before subjecting it to blackwashing and a final drying operation.

In building up the bricks every precaution should be taken to ensure the rapid escape of the gases during casting. For this purpose, the brick joints are packed with fine coke breeze. A channel, lined with slightly coarser coke breeze is formed round the brick course. At the four corners of the vent are placed large pipes running to the foundry floor, their function being to facilitate the escape (always under pressure) of all the gases from the bottom part.

(*b*) *Coremaking.*—The core, like the cope, is built in two operations. The bottom of the core is strickled with the board C (Fig. 4) and stove-dried for 24 hrs. During this time a false core or "cake" is strickled, with the board B, on a plate provided with lugs and also stove-dried. After drying, the bottom of the core is turned up into the false core (Fig. 5), the brick course being then completed by means of the board E.

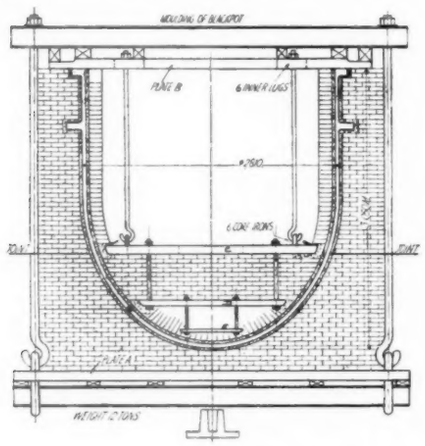


FIG. 2.—SECTION THROUGH A MOULD FOR BLACKPOT.

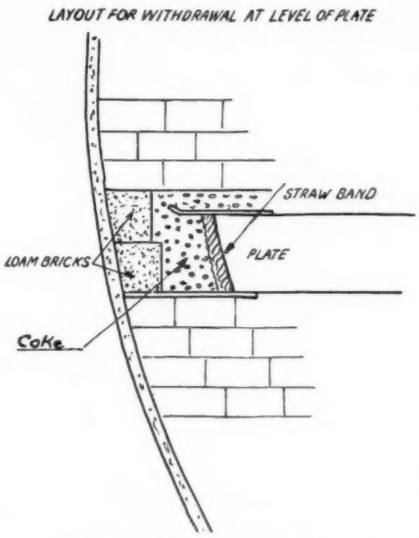


FIG. 3.—MEANS ADOPTED FOR EASY REMOVAL OF CORE.

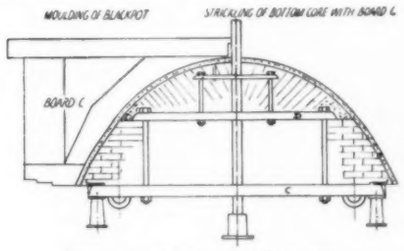


FIG. 4.—CORE FOR BLACKPOT.

Gates and Risers.—Experience has shown that for this casting, casting should take about 120 sec. The amount of metal to be run in per sec. is therefore 100 kg. It is assumed that the normal speed at which the metal flows into the gates to be 2 metres per sec. Thus:

$$\text{Section of down-gate} : \frac{100}{20 \times 7.2} = 0.76 \text{ dm.}^2$$

the diameter of the gate being therefore = 0.94 dm., *i.e.*, practically 100 mm.

In calculating the dimensions of the risers, the amount of air to be expelled during the 120 sec. must be ascertained. The volume of the mould is:

$$\frac{12{,}000}{7.2} = 1{,}666 \text{ dm.}^3$$

but taking into consideration the gases formed while pouring, it is judged to be necessary to multiply this figure by a coefficient of 1.5. The amount to be expelled per sec. is therefore:

$$\frac{1{,}666}{120} \times 1.5 = 20.85 \text{ dm.}^3 \text{ of air and gas.}$$

In order to avoid any trouble, these gases should not, in our personal opinion, escape at a speed of more than 0.20 m. per sec. Thus:

$$\text{Total section of risers} = \frac{20.85}{2} = 10.42 \text{ dm.}$$

These observations as to the calculations for the gates and risers apply to all the castings hereinafter mentioned.

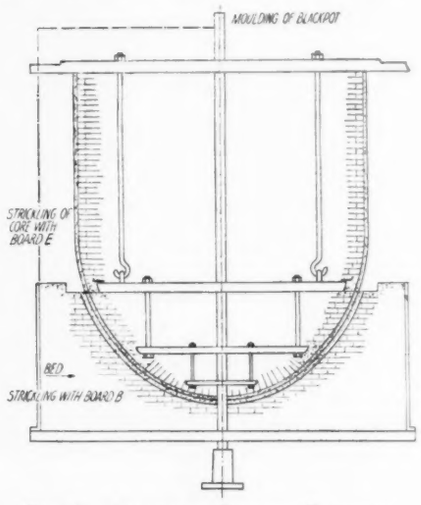


FIG. 5.—ASSEMBLED CORE FOR BLACKPOT.

Assembling

Before assembling, it is necessary to check carefully the height of the mould as a subsidence of the brick courses is to be reckoned with. Sand is rammed between the outside of the brickwork and the wall of the pit so as to counterbalance the lateral pressures set up at the time of pouring. This operation should be very carefully carried out, and wherever large castings are concerned all the pressures are to be calculated so as to avoid any error at the time of pouring. The core is then lowered and the top plate and the anchorage are bolted together, as indicated in Fig. 2.

Horizontal Strickle Moulding (Rolling-Mill Roll, weight 2,300 kg.)

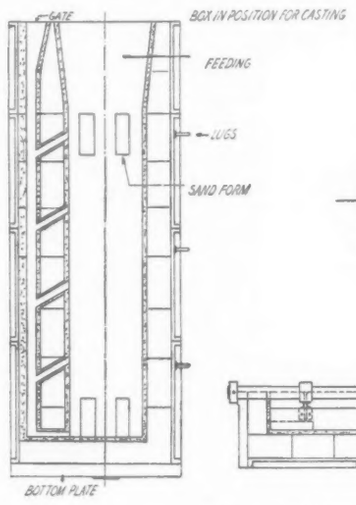
The horizontal strickle board is used for strickling in the horizontal position castings which are then poured vertically. In this method of strickling (Fig. 6) the socket is dispensed with. One end of the spindle B carries a square nut which enables a handle to be fitted. For the present casting, four clamps C are fixed to the spindle so as to give to the strickle board the necessary rigidity. As shown in Fig. 6, the moulding boxes (two half-parts) are of a special type and carry on their two small ends, bearings bored to the diameter of the spindle, while their axes corresponds to the mould joint.

The inner walls of the half-parts are bricked up. The loam is then rammed over this brickwork, while strickling is effected as shown in the drawing. The two half-moulds are stove-dried, then assembled and again stove-dried. The two portions are fastened by bolts, of square section, after which the mould is placed in position for casting.

Eccentric Strickle Moulding (Grooved Flywheel in two half-parts, weight 4,000 kg.)

The flywheel shown in Fig. 7 is made by eccentric moulding and is cut by cakes A, B, E, F.

Patternmaking.—The equipment includes:—(*a*) A board for strickling the bottom portion *a*, *b*, *c*, *d*, *e*, *f*; (*b*) a board for strickling the outside of the grooves; (*c*) a board for strickling the inside of the grooves; (*d*) a board for strickling the hub; (*e*) a loam-cake box for making the loam bricks which are to rough-out the grooves, and (*f*) a pattern for the half-spokes and various other parts.



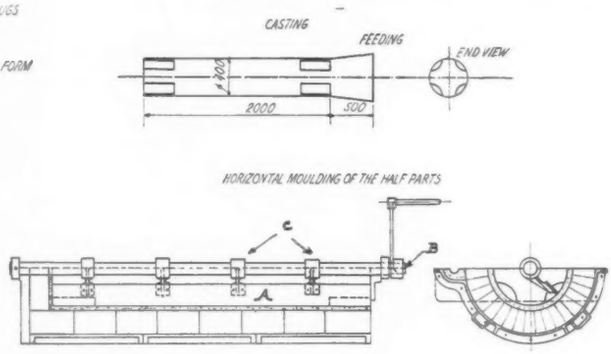


FIG. 6.—EXAMPLE OF HORIZONTAL STRICKLING.

Moulding.—A thick course of coke breeze is prepared, in order to facilitate the escape of the gases at the time of pouring, while the bottom of the mould *a*, *b*, *c*, *d*, *e*, *f* is strickled; the joint at *a*, *b* represents the seating of the cope plate. The bottom is bricked up at *a*, *b* and *e*, *f* below the hub and at the seatings for the spokes.

When the bottom is dry the positions of the spokes are marked, the spokes themselves having been made separately, in half-sections, on plates provided with lugs, and then assembled. The spokes are then placed flush with the supporting sand, which is rammed under the plate. After laying the spokes, the building up of the inner part of the wheel is begun, this pattern being strickled in loam. The same operation is effected in respect of the hub. Special attention should be paid to the joining of the spokes with the rim and the hub. The covering plates of rim and hub are struck up separately.

Strickling the Body.—The body is strickled on the plate *a*, *b*, *e*, *f*, this operation being effected separately. The body is built up by means of loam bricks designed to rough-out the required grooves and placed in position with the aid of the strickle board. After drying, the body is finished by adding soft loam and strickling in the usual way. This method of making flywheels is very economical from the standpoint of patternmaking and moulding.

(*To be concluded.*)

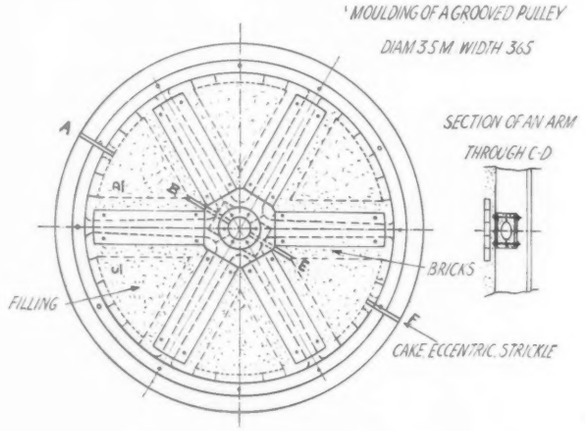
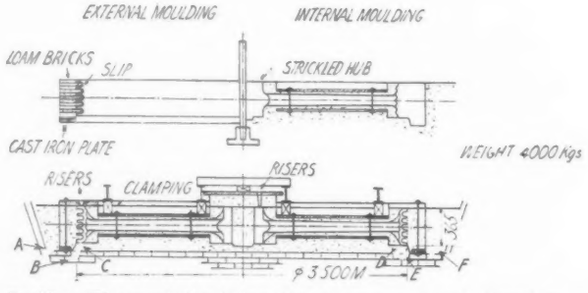


FIG. 7.—METHOD OF MOULDING A GROOVED PULLEY.



Moulding Tackle.—The moulding being done in a pit, an annular plate is necessary to brick up the joint, a similar plate to cover the rim and a plate to cover the hub; also plates provided with lugs upon which the half-spokes are to be moulded and then assembled (see section CD).

THE UNITED STEEL COMPANIES LTD.

UCO "MW"

For Whiteheart Malleable Castings

UCO "MB"

For Blackheart Malleable Castings

Foundrymen are more and more turning to UCO All-Mine Irons for their requirements. UCO Irons ensure castings of quality and reliability however severe the wear and stresses to which they are subjected. UCO All-Mine Irons are *sold only to analysis and a complete analysis is supplied with each consignment.* Below are specimen analyses of these Irons, made from several representative casts.

UCO "MW" GRADES

	A.1.	A.2.	A.3.	B.1.	B.2.	B.3.	C.1.	C.2.	C.3.
Total Carbon	2·60	2·68	3·04	2·60	3.00	2·60	3·00	2·60	3·20
Silicon	0·56	0·51	0·50	0·76	0·84	1·00	1·00	1·26	1·44
Sulphur	·034	·043	·050	·031	·052	·060	·050	·052	·030
Phos.	·043	·037	·043	·040	·037	·039	·040	·044	·043
Manganese	·10	·23	·33	·28	·22	·30	·25	·15	·30

OTHER ANALYSES AS REQUIRED TO CUSTOMERS' SPECIFICATIONS

Here are definite reasons for the increasing adoption of UCO Irons.

★ UCO is supplied in small sand-cast pigs.
★ UCO is suitable for both crucible and cupola melting.
★ UCO is not a synthetic or so-called "refined" iron.
★ UCO has a carbon percentage not achieved by dilution with steel scrap.
★ UCO is not desulphurised iron. (Note low sulphur content).
★ UCO is made entirely from West Coast Hematite materials.
★ UCO can be supplied in suitable grades for light or heavy castings.
★ UCO is sold to guaranteed analyses and each consignment is uniform.

Write for copies of booklets W111 (UCO "MW" and "MB" for Malleable Castings), W128 (UCO "W" for Special Castings), and W109 (Foundry Irons). When writing, please give name, firm's name and address, and position in firm.

INDEPENDENT TEST CERTIFICATES

on annealed malleable castings, supplied by a user of "M.W." UCO Iron.

For Messrs._____ 50% U.C.O. used. No. 2968

Contract No._____

Tested in the presence of_____

Date	Description	Dimension	Area	BREAKING STRAINS On piece	BREAKING STRAINS On Sq. in.	ELONGATION EXTENSION in 2 inches Per cent.	ANALYSIS OF ANNEALED TEST BAR T.Carb.	Sil.	Sul.	Phos.	Mn.
1930 Oct. 10	Malleable Sample	.580 dia.	.264	6.7	25.3	7.0	.80	.46	.08	.04	.12

For Messrs._____ 100% U.C.O. used. No. 2968

Contract No._____

Tested in the presence of_____

Date	Description	Dimension	Area	BREAKING STRAINS On piece	BREAKING STRAINS On Sq. in.	ELONGATION EXTENSION in 2 inches Per cent.	ANALYSIS OF ANNEALED TEST BAR T.Carb.	Sil.	Sul.	Phos.	Mn.
1930 Oct. 10	Malleable Sample	.585	.268	6.7	25.0	10.0	.41	.70	.075	.04	.20

WORKINGTON IRON & STEEL COMPANY
Branch of
The United Steel Companies Limited
WORKINGTON CUMBERLAND

W10

This Week's News in Brief

Trade Talk

THE ROTARY AIR COMPRESSOR COMPANY, LIMITED, announce that their address is now 119, Victoria Street, London, S.W.1.

THE USKSIDE ENGINEERING COMPANY, LIMITED, Newport, Mon, have orders for eleven electric hoists for the South African goldfields.

THE IMPORTS of iron and steel into the Tees for the month of June comprised 10 tons of pig-iron, 6,275 tons of steel semis and 457 tons of manufactured iron and steel, a total of 6,742 tons, which compares with 4,778 tons in May and 1,844 tons in April.

MESSRS. DOUGLAS ELLIOT & COMPANY, LIMITED, iron and steel merchants, of Atlas Chambers, King Street, Leeds, 1, have taken over the business of Messrs. N. J. Barr, Limited, steel stockholders, 3, Wellington Road, Leeds, 12, which will in future be carried on by Messrs. Douglas Elliot & Company in their name at the Wellington Road address. Mr. N. J. Barr and Mr. T. H. Barr retire, and the stockyards will be under the personal supervision of the directors of Messrs. Douglas Elliot. The structural engineering side of the business will be discontinued.

THE RECEIVER, under whose management the business of Messrs. Davy Bros., Limited, Park Iron Works, Sheffield, has been carried on for the past ten months, has now been discharged by the Court. The capital of the company has been reorganised, and sufficient fresh capital has been provided to ensure that work of any magnitude can be dealt with and executed. The new board of directors consists of Mr. E. J. Fox, of the Stanton Ironworks Company (chairman); Mr. A. Peech, of United Steel Companies, Limited, and Mr. R. F. Norland, of the Industrial Finance & Investment Corporation, Limited.

LARGE MODERN STEELWORKS were foreshadowed for Jarrow when the Tyne Improvement Commission conducted members of the North of England Shipowners' Association on a tour of the Tyne recently. Mr. H. P. Everett, chairman of the Commission, at a luncheon on board the Commissioners' launch, stated that they were bound to pay tribute to the work of Sir John Jarvis, who was attempting to find work for Jarrow people. Mr. Everett stated Sir John was "up against" certain interests in his efforts to re-start the Jarrow steelworks. There were, however, assurances that the difficulties would be cleared up within a few weeks and that new steelworks would be started at Jarrow. They could only wait for the final decision of the promoters and the financiers.

IRON AND STEEL IMPORTS into the Irish Free State for the month of April, just issued, show a total of £151,055, against £221,791, making for the first four months of the year £635,436, against £638,515. Iron bars and rods imported for the month were £4,273, making £13,508 for the four months, and steel bars £15,216, making £64,994. Steel girders and joists, not fabricated, were £4,250, making £21,071; iron and steel manufactures, constructional, fabricated, £5,833, making £12,120; plates and sheets, not coated, £4,213, making £15,716; plates and sheets, coated, £15,600, making £73,800; railway material, £7,400, making £36,700; wire manufactures, £2,500, making £17,000; bolts, nuts and screws, £2,993, making £15,088; domestic stoves, ranges and grates, £13,363, making £43,449; nails, tacks, rivets and washers, £7,601, making £35,679. Imports of non-ferrous ores, metals, etc., for the month were £36,386, making £152,724 for the four months, and machinery and electrical goods £177,098, making £788,500. Imports of agricultural machinery reached £3,248, making for the four months' period £12,144; and boilers and boiler-house plant £2,995, making £11,552.

Contracts Open

Cairo, July 29.—Ball and roller bearings, for the Ministry of Public Works. The Department of Overseas Trade. (Reference G.Y. 15,274.)

Copenhagen, August 13.—Boiler plant, etc., for the Copenhagen Lighting Department. The Department of Overseas Trade. (Reference G.Y. 15,280.)

Personal

MR. WILLIAM R. LONG, of Stewarts and Lloyds, Limited, has been elected chairman of the Badminton Club.

MR. EDWARD HUGH ARMITAGE has been elected a director of Messrs. Brown Bayley's Steelworks, Limited, Sheffield.

MR. J. PATERSON, of Messrs. Wright, Johnson & Mackenzie, Glasgow, has been elected a director of Messrs. Yarrow & Company, Limited, shipbuilders, Glasgow.

SIR GEORGE MAY, BT., chairman of the Import Duties Advisory Committee, who was recently made a peer, has assumed the title of Baron May of Weybridge, in the County of Surrey.

MR. S. A. MAIN, of the research department of Messrs. Hadfields, Limited, Sheffield, has been awarded the silver medal of the Royal Society of Arts, for his Paper on "Properties, Characteristics and Uses of Stainless Steel."

SIR ARTHUR BALFOUR, who was awarded a peerage in the King's Birthday Honours list, has assumed the title of Baron Riverdale of Sheffield. Lord Riverdale, who has his seat at Riverdale Grange, Sheffield, is managing director of Messrs. Arthur Balfour & Company, Limited, and chairman of C. Meadows & Company, Limited, Sheffield, and of High Speed Steel Alloys, Limited, Widnes.

Obituary

MR. THOMAS E. BURNETT, proprietor of the Maples Foundry Company, Phœnix Works, West Bromwich, died recently, at the age of 61.

MR. PETER THORNTON, who was for many years works manager with Messrs. Dickson & Mann, Limited, Armadale, has died, at the age of 52.

MR. JOHN WATSON, a director of Messrs. Andrew Barclay, Sons & Company, Limited, locomotive builders, Caledonia Works, Kilmarnock, died recently.

MR. ROBERT THOMSON, iron and steel merchant, of Kilmarnock, died recently. Since the death of his father many years ago he had been sole partner of the firm of John Thomson & Son, iron and metal merchants.

MR. ALBERT DEIGHTON, who was successively chief engineer and general manager of the works of Messrs. Steel, Peech & Tozer, Rotherham, has died at the age of 63, at Cheltenham, where he lived in retirement.

MR. T. R. ELLIN, who died in Sheffield on June 28, aged 74, was Master Cutler in 1925, being the fourth member of his family to hold that position. He was head of the firm of Thomas R. Ellin (Footprint Works), Limited, manufacturers of engineers' tools, of Hollis Croft, Sheffield.

MR. JOHN JAMES CAMERON, commercial manager and director of Messrs. A. & J. Main & Company, Limited, structural engineers, Possilpark, Glasgow, died recently, at the age of 69. He had been connected with the firm for many years, and played a prominent part in expanding the business. He was a member of Hamilton Town Council, ultimately being promoted to the magistracy. Owing to pressure of business he retired from public life about six years ago.

Company Report

Greenwood & Batley, Limited.—Profit to March 31, £36,794; brought in, £14,012; to depreciation, £10,000; preference dividend, £7,028; ordinary dividend of 4 per cent., £13,935; carried forward, £19,843.

Fe-Co-Sn System

W. KÖSTER and W. GELLER, in the "Archiv für das Eisenhüttenwesen," discuss the structure of the ternary system iron-cobalt-tin up to tin contents of 40 per cent. The phase-rule diagram and the mechanical and physical properties of the system have been investigated and are described.

Silicon and the Stability of Cubic Martensite

H. BUMM and U. DEHLINGER, at the Kaiser-Wilhelm-Institut für Metallforschung, Stuttgart, have studied the effect of silicon on the stability of cubic martensite by means of X-rays using steels containing 0.5 to 1 per cent. carbon and 0 to 5 per cent. nickel or 0 to 0.5 per cent. manganese, prepared from electrolytic iron in the high-frequency vacuum furnace in alumina crucibles. According to the authors' report in "Stahl und Eisen," it was found that by ordinary quenching in water the tetragonal lattice of martensite, which was to be expected from previous investigations, is not obtained, but always the more or less wide lines indicative of a cubic space-centred lattice similar to that of ferrite. After a considerable amount of examination, it was established that this divergent behaviour was due to the absence of the silicon content usually found in ordinary steel, for after adding 0.3 per cent. Si tetragonal martensite was obtained without difficulty. On the other hand, the absence of manganese or nickel had no observable effect on the formation of the tetragonal lattice. By very rapid quenching, using a paste described by S. Satô which inhibits the formation of a jacket of steam on the surface, a tetragonal lattice could, however, be obtained also in the silicon-free material. By heating to above 90 deg., the tetragonal skiagram was always converted to a cubic one, at first diffuse, but later well defined. The microscopic structure was observed to be always martensitic, while in the non-nickel steels small quantities of troostite were visible.

These experiments have confirmed the existence of cubic martensite, as described by K. Honda and S. Sekito, *i.e.*, the presence of a condition typified by martensitic structure and high hardness, but with a cubic space-centred lattice, which is formed comparatively rapidly from the tetragonal form and hence probably still contains carbon in solution. The initial widening of the cubic lines on the transition from the tetragonal lattice, which has sharp lines in the skiagram, shows that this transition consists of a continuous modification in lattice structure. Cubic martensite must therefore be regarded as a preparatory condition for the eventual precipitation of the carbon from tetragonal martensite and in an atomic sense is determined probably by a polymerisation of the dissolved atoms, similar to the cold-refined state of duralumin.

The authors suggest that the silicon in steel can only inhibit the formation of a cubic lattice in three ways:—(1) By retarding the direct decomposition of austenite (formation of troostite) above the martensite temperature; but since only small quantities of troostite are detected under the microscope this effect is not pronounced in the present experiments. (2) By reducing by suitable means the martensite temperature and hence restricting the temperature range to be traversed by the tetragonal martensite. However, the direct measurement of the martensite temperature by F. Wever and N. Engel, who investigated non-silicon and siliceous steels with low carbon contents, does not show that the silicon has any marked influence on the martensite temperature. (3) It is probable, therefore, that the third possibility is more apposite, viz., a direct retardation of the formation of a cubic lattice from the tetragonal martensite, in which some sort of displacement of the carbon atoms must take place which may be restricted or inhibited by the dissolved silicon.

MR. V. JOBSON, chairman and managing director of Qualcast, Limited, Derby, has joined the board of Simms Motor Units, Limited. Major S. A. Currin has joined the board as sales director.

The largest producers of Pig Iron (for Sale) in Great Britain

THE
STANTON
IRONWORKS COMPANY LIMITED
Near NOTTINGHAM

Raw Material Markets

Conditions remain favourable. It was expected that more contracts for pig-iron would have been renewed with the passing of the first half of the year than has been the case. Orders are comparatively small in quantity and for early delivery. Total deliveries, however, are large. Semi-finished steel continues to be firm. Finished steel remains in good demand, although orders for thick plates are not frequent. Railway material, joists and sections are having numerous inquiries.

Pig-Iron

MIDDLESBROUGH.—The output of Cleveland pig-iron is at an unchanged level, and it is consumed almost immediately it is raised from the pig beds. Owing to the domestic consumption being heavy, very little iron remains available for export purposes. Large deliveries, of about 1,000 tons a week, have been going to Scotland, but have been temporarily reduced with the arrival of the holiday season. Home prices remain unchanged at last week's firm figures. No. 3 Cleveland G.M.B. is at 67s. 6d. per ton delivered in the Middlesbrough district, 69s. 6d. delivered North-East Coast, 67s. 3d. delivered Falkirk and 70s. 3d. delivered Glasgow.

A good demand continues for East Coast hematite. Only seven furnaces are active on this grade and the output is going away easily. The home trade continues to absorb large quantities of hematite. Quotations are as follow:—No. 1 quality, 69s. per ton delivered Middlesbrough, 71s. delivered North-East Coast, 75s. delivered Scotland, 76s. delivered Lancashire, 75s. to 78s. delivered Yorkshire, and 79s. delivered South Staffordshire.

LANCASHIRE.—Deliveries of foundry pig-iron have in some cases been suspended owing to local holidays, but business has been well maintained as a whole. Fairly large quantities are being consumed by the light-castings makers, and also by the heavy electrical-engineering firms. Very few new contracts have been effected and users are only able to renew expiring commitments. Staffordshire, Derbyshire and Lancashire brands of No. 3 foundry iron are all quoted on the basis of 74s. per ton delivered in the Lancashire price zone, and Northamptonshire at 72s. 6d. East Coast hematite remains unchanged at from 75s. to 76s. per ton, according to grade, and West Coast hematite is at 78s. 6d.

MIDLANDS.—Little forward buying has occurred since the controlled prices of Midland brands of foundry iron were re-affirmed. The light-castings, general engineering and jobbing sections, however, are still large consumers, and deliveries are on a good scale. Controlled prices for common iron are 67s. 6d. per ton for Northants No. 3, and 71s. for Derbyshire, Lincolnshire and North Staffs No. 3, including delivery to Birmingham and Black Country stations, and subject to a small graduated rebate in certain cases. Medium-phosphorus iron is at from 72s. to 80s. per ton and low-phosphorus iron, including Scottish, is at from 85s. to 90s. Special refined iron for engine and similar work is from £5 7s. 6d. to £7, delivered in the Birmingham district. No change in the price of East Coast hematite has been noted, the figure for No. 3 grade, delivered the Birmingham district, being 78s. per ton. The West Coast controlled rate is 84s. 6d. per ton.

SCOTLAND.—Holidays continue to influence trade and the market is quiet. No changes in prices have been reported and the minimum of 70s. for Scottish No. 3 foundry f.o.t. furnaces with 2s. 6d. added for No. 1 is still current. Cleveland iron is 67s. 3d. f.o.t. Falkirk and 70s. 3d. f.o.t. Glasgow for No. 3 foundry.

Coke

Very little change is reported in the foundry coke market and the quiet conditions are expected to prevail until consumers begin to cover their winter needs in early September. Best Durham coke is offered at from 34s. to 40s., Welsh from 31s. to 42s. 6d., and Scottish coke from 39s. 6d. to 40s. 6d. per ton delivered Midland points.

Steel

The holiday season which has commenced in the industrial districts has begun to influence business in steel. Deliveries to the consuming works in some areas have been suspended for a time, but it is anticipated that the holiday stoppages will have a comparatively small effect upon the market position this year, and that when deliveries are resumed they will be on a substantial scale. Business in semi-finished steel has become somewhat quieter again, and most of the consumers appear to have covered their forward requirements for the time being. In some cases consumers are carrying heavy stocks and are not obliged to do more than buy small supplementary parcels. The producing works are making heavy deliveries to users and have sufficient orders on their books to keep them busy for the next two or three months. In the finished-steel department the works in practically all departments are operating at a high rate. Business in heavy plates, however, is quiet, and most of the mills will be glad to obtain fresh orders. The home demand with this exception continues to provide a substantial outlet for most classes of steel, and particularly of structural steel. Export business on the whole is maintained, but any expansion is checked by the difficulty of transacting business with many foreign markets.

Scrap

Heavy melting steel is in good demand in the Cleveland district, but in spite of this the price remains steady at 52s. 6d. per ton delivered works. Machinery cast-iron scrap is from 54s. to 55s. per ton, and clean light iron is in better favour at 42s. 6d. to 43s. In the Midlands a good call for all qualities is reported and prices are firm. Heavy steel in furnace sizes is at 45s. to 46s. and cast-iron scrap has a steady demand. Heavy machinery metal in handy sizes is at 55s. to 57s. 6d., good heavy at 50s. and clean light at 47s. 6d., all delivered works. A steady market for iron and steel scrap exists in Yorkshire and prices are inclined to rise. In Lancashire, light and heavy cast-iron machinery scrap is only in moderate demand at from 50s. to 55s. per ton, including delivery.

Metals

Copper.—Buying of this metal has been good and the value of standard copper has remained fairly steady. On account of the domestic situation in the United States less American electro has been offered for sale in this country. The rise in the price of standard copper caused consumers of Europe to buy more refined metal. The outlook is brighter and buyers are negotiating with more confidence.

Daily market prices:—

Cash.—Thursday, £30 8s. 9d. to £30 10s.; Friday, £30 3s. 9d. to £30 6s. 3d.; Monday, £29 13s. 9d. to £29 15s.; Tuesday, £29 18s. 9d. to £30 1s. 3d.; Wednesday, £30 6s. 3d. to £30 8s. 9d.

Three Months.—Thursday, £30 17s. 6d. to £30 18s. 9d.; Friday, £30 12s 6d. to £30 13s. 9d.; Monday, £30 1s. 3d. to £30 2s. 6d.; Tuesday, £30 7s. 6d. to £30 10s.; Wednesday, £30 13s. 9d. to £30 16s. 3d.

Tin.—The price of this metal has remained firm. Specifications from the Continent and Wales have been received and the market is strongly controlled. A large tonnage has been taken by America recently and this has helped to maintain the price.

Day-to-day fluctuations:—

Cash.—Thursday, £230 15s. to £231; Friday, £230 5s. to £230 15s.; Monday, £230 15s. to £231; Tuesday, £230 15s. to £231; Wednesday, £231 to £231 5s.

Three Months.—Thursday, £225 to £225 5s.; Friday, £224 to £224 10s.; Monday, £224 15s. to £225; Tuesday, £224 10s. to £224 15s.; Wednesday, £224 to £224 10s.

Spelter.—Prices have remained steady and the demand has been moderate. Conditions are expected to improve considerably when the anticipated reduction of the duty comes into force. Quiet conditions prevail on the Continent and buyers are showing a cautious attitude. A slight improvement in demand is reported from the United States and the market there is steady.

Official quotations were as follow:—

Ordinary. — Thursday, £13 15s.; Friday, £13 12s. 6d.; Monday, £13 15s.; Tuesday, £13 16s. 3d.; Wednesday, £13 13s. 9d.

Lead.—Prices have been fluctuating slightly this week, but very little change has occurred. Consumption continues to be satisfactory and an optimistic outlook prevails. As in the case of spelter, the market is generally expected to improve with the anticipated reduction in the duty. Consumers are very reluctant to deal in large quantities, but upon the reduction in the duty the benefits should be more pronounced.

Day-to-day quotations:—

Soft Foreign (Prompt).—Thursday, £13 13s. 9d.; Friday, £13 15s.; Monday, £13 13s. 9d.; Tuesday, £13 16s. 3d.; Wednesday, £13 18s. 9d.

Anglo-Turkish Trade Agreement

A trade agreement between the Government of the United Kingdom and the Government of Turkey was signed at Angora on June 4, and came into force provisionally, pending ratification, on June 20. The agreement aims at facilitating the commercial relations between the two countries and, having regard to the exceptional economic conditions which have made it necessary for Turkey to apply to all other countries the principle of the balance of payments, permits certain United Kingdom goods enumerated in a First Schedule to be imported into Turkey without any restriction as to quantity, while United Kingdom goods enumerated in a Second Schedule will be permitted to be imported into Turkey up to the quantities specified in the schedule for each article. United Kingdom goods other than those specified in these two schedules will enjoy the benefit of the general quota *régime* in force in Turkey. In return for these concessions Turkish goods enumerated in a Third Schedule shall, on importation into the United Kingdom, not be subjected to duties or charges other or higher than those specified in that schedule. The Turkish Government will also consider sympathetically any proposal of the Government of the United Kingdom for replacing in whole or in part by specific duties any of the *ad valorem* duties or by an *ad valorem* duty the specific duty set out in the schedule.

The goods in the First Schedule which may be imported into Turkey without restriction as to quantity include the following in the Turkish Tariff:—No. 529: Pipes, conduits, joints of all kinds (including those enamelled, or insulated by means of tarred cloth, etc.): A, of cast iron; B, of wrought iron or steel; C, of galvanised iron. No. 531: Heavy wares of cast iron or iron, such as vats, crucibles, poles, plates (perforated or otherwise), railway points and signals, parts of buildings, whether assembled or not; sheet iron cut or stamped for use in reinforced concrete; heavy iron wares for ships, railways, buildings and similar purposes (except finished machine parts).

Austenite Transformation

Outlining practical research on the lag in austenite transformation, in the "Archiv für das Eisenhüttenwesen," E. SCHEIL points out that this lag is determined by the time taken for a nucleus to be formed of the transformation product. The lag may in fact be calculated from the connection between the transformation temperature and the velocity of cooling. The temperature coefficient of the lag is found to have a minimum value which has, however, not yet been determined for individual cases. Using calculations of T. Sato, the author has plotted a phase diagram with ferrite, cementite and pearlite regions, and by means of the diagram he shows that a pearlite twin-nucleus is formed more easily in the pearlite region than a mono-nucleus of ferrite or cementite. The effect of any ferrite or cementite crystals already present is small and is overshadowed by the effect of the carbon content of the austenite on nuclear formation. The action of inoculants in inducing ferrite formation is in descending order: sulphides, grain boundaries of austenite, and oxides.

XUM

Upon this rock!

Our reputation for good ground ganister has been built by using only genuine ganister rock and special refractory clays, blended by craftsmen who understand their work. Consistency in supplies and definite economy in service are assured.

GENERAL REFRACTORIES LIMITED

Phone :
Sheffield 22311
London, Temple Bar 7361

Head Office : Genefax House, Sheffield
London Office : Russell House, Adelphi, W.C.2

Grams :
Genefax, Sheffield
Genefax, Rand, London

RAW MATERIALS—PRICE LIST

(Wednesday, July 10, 1935)

COPPER

	£	s.	d.
Standard cash	30	6	3
Three months	30	13	9
Electrolytic	33	10	0
Tough	32	0	0
Best selected	32	10	0
Sheets	60	0	0
India	43	5	0
Wire bars	34	0	0
Ingot bars	33	15	0
H.C. wire rods	37	10	0
Off. av. cash, June	30	16	8 11/16
Do., 3 mths., June	31	4	1 1/16
Do., Sttlmnt., June	30	16	10 3/16
Do., Electro, June	34	7	4 5/16
Do., B.S., June	33	13	1 1/2
Do., wire bars, June	34	13	11 7/16
Solid drawn tubes			9¾d.
Brazed tubes			9¾d.
Wire			6¼d.

BRASS

Solid drawn tubes	9d.
Brazed tubes	11d.
Rods, drawn	8d.
Rods, extd. or rlld.	4¼d.
Sheets to 10 w.g.	7¾d.
Wire	7¾d.
Rolled metal	6¼d.
Yellow metal rods	4¼d.
Do. 4 × 4 Squares	5¾d.
Do. 4 × 3 Sheets	5¾d.

TIN

	£	s.	d.
Standard cash	231	0	0
Three months	224	0	0
English	231	0	0
Bars	232	15	0
Straits (nom.)	244	15	0
Australian (nom.)	231	5	0
Eastern	230	10	0
Banca (nom.)	236	15	0
Off. av. cash, June	227	14	3 6/16
Do., 3 mths., June	219	10	9 3/16
Do., Sttlmt., June	227	14	5 13/16

SPELTER

	£	s.	d.
Ordinary	13	13	9
Remelted	14	10	0
Hard	11	15	0
Electro 99.9	16	5	0
English	14	17	6
India	12	15	0
Zinc dust	18	10	0
Zinc ashes	3	5	0
Off. aver., June	13	16	3 1/16
Aver. spot, June	13	14	8 1/16

LEAD

	£	s.	d.
Soft foreign ppt.	13	18	9
Empire (nom.)	14	18	9
English	16	0	0
Off. average, June	13	15	9 13/16
Average spot, June	13	15	6 9/16

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	22	17	6
Do., V.M. ex-whse.	23	10	0
Rods	28	15	0

ANTIMONY

	£	s.	d.		£	s.	d.
English	74	0	0	to	75	0	0
Chinese, ex-whse.					68	0	0
Crude, c.i.f.					25	5	0

QUICKSILVER

	£	s.	d.		£	s.	d.
Quicksilver	11	2	6	to	11	12	6

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	£8 17 6
45/50%	£12 15 0
75%	£17 17 6
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	4/6 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£15 15 0
Ferro-tungsten—	
80/85%	3/- lb.
Tungsten metal powder—	
98/99%	3/3 lb.
Ferro-chrome—	
2/4% car.	£33 10 0
4/6% car.	£21 15 0
6/8% car.	£21 0 0
8/10% car.	£21 0 0
Ferro-chrome—	
Max. 2% car.	£34 0 0
Max. 1% car.	£36 5 0
Max. 0.70% car.	£37 5 0
70%, carbon-free	9¾d. lb.
Nickel—99.5/100%	£200 to £205
"F" nickel shot	£184 0 0
Ferro-cobalt, 98/99%	5/6 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/8 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 3/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ¼ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

South Wales—	£	s.	d.		£	s.	d.
Heavy steel	2	15	0	to	2	16	0
Bundled shrngs.	2	7	6	to	2	8	6
Mixed iron and steel	2	10	0	to	2	12	0
Heavy cast iron	2	10	0	to	2	12	6
Good machinery	2	12	6	to	2	15	0
Cleveland—							
Heavy steel					2	12	6
Steel turnings					1	15	0
Cast-iron borings					1	5	0
Heavy cast iron					2	12	6
Heavy machinery	2	14	0	to	2	15	0
Midlands—							
Light cast-iron scrap					2	7	6
Heavy wrought iron					2	17	6
Steel turnings					1	14	0
Scotland—							
Heavy steel					2	10	0
Ordinary cast iron					2	12	6
Engineers' turnings					2	0	0
Cast-iron borings	1	17	6	to	2	0	0
Wrot-iron piling					2	17	6
Heavy machinery					2	16	6

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	26	0	0
Brass	17	0	0
Lead (less usual draft)	12	10	0
Tea lead	9	10	0
Zinc	8	10	0
New aluminium cuttings	66	0	0
Braziery copper	22	0	0
Gunmetal	24	0	0
Hollow pewter	155	0	0
Shaped black pewter	110	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	70/-
Foundry No. 3	67/6
,, at Falkirk	67/3
,, at Glasgow	70/3
Foundry No. 4	66/6
Forge No. 4	66/6
Hematite No. 1	69/-
Hematite M/Nos.	68/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	72/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	67/-
,, No. 3 fdry.	71/-
Northants forge	63/6
,, fdry. No. 3	67/6
,, fdry. No. 1	70/6
Derbyshire forge	67/-
,, fdry. No. 3	71/-
,, fdry. No. 1	74/-
Scotland—	
Foundry No. 1, f.o.t.	72/6
,, No. 3, f.o.t.	70/-
Hem. M/Nos. d/d	71/-
Sheffield (d/d district)—	
Derby forge	64/6
,, fdry. No. 3	68/6
Lincs forge	64/6
,, fdry. No. 3	68/6
E.C. hematite	81/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	74/-
Staffs fdry. No. 3	74/-
Northants fdry. No. 3	72/6
Cleveland fdry. No. 3	74/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	82/-
Clyde, No. 3	82/-
Monkland, No. 3	82/-
Summerlee, No. 3	82/-
Eglinton, No. 3	82/-
Gartsherrie, No. 3	82/-
Shotts, No. 3	82/-

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)	9	12	6	to	9	15	0
Nut and bolt iron	7	10	0	to	8	0	0
Hoops	10	10	0	and up.			
Marked bars (Staffs) f.o.t.					12	0	0
Gas strip				10 10 0 and up.			
Bolts and nuts, ¾ in. × 4 in.				14 2 6 and up.			
Steel—							
Plates, ship, etc.	8	15	0	to	8	17	6
Boiler plts.	9	5	0	to	9	7	6
Chequer plts.					10	7	6
Angles					9	7	6
Tees					9	7	6
Joists					8	15	0
Rounds and squares, 3 in. to 5½ in.					9	7	6
Rounds under 3 in. to ⅜ in. (Untested)					8	12	0
Flats—8 in. wide and over					8	12	6
,, under 8 in. and over 5 in.					8	17	6
Rails, heavy	8	5	0	to	8	10	0
Fishplates	12	5	0	to	12	10	0
Hoops (Staffs)					9	7	0
Black sheets, 24g. (4-t. lots)					10	10	0
Galv. cor. shts. (,,)					13	0	0
Galv. flat shts. (,,)					13	10	0
Galv. fencing wire, 8g. plain					14	10	0
Billets, soft	5	10	0	and up.			
Billets, hard	6	17	6	to	7	2	6
Sheet bars	5	2	6	to	5	7	6
Tin bars	5	5	0	to	5	7	6

PHOSPHOR BRONZE

Per lb. basis.

Strip	9¾d.
Sheet to 10 w.g.	11½d.
Wire	11¾d.
Rods	11d.
Tubes	13½d.
Castings	12d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

Per lb.

Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1⅝ to 1/7⅛
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2⅛ to 1/8⅛
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	20.31
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic, Valley	18.00
Malleable, Valley	18.50
Grey forge, Valley	18.00
Ferro-mang. 80%, seaboard	85.00
O.-h. rails, h'y, at mill	36.37½
Billets	27.00
Sheet bars	28.00
Wire rods	38.00
	Cents.
Iron bars, Chicago	1.80
Steel bars	1.80
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.70
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.10
Wire nails	2.60
Plain wire	2.30
Barbed wire, galv.	3.00
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/- to 30/-
,, furnace	19/- to 20/-
Durham foundry	19/- to 22/-
,, furnace	16/6 to 17/9
Scotland, foundry	28/-
,, furnace	25/-

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20 × 14 per box	18/2 to 19/2
,,	28 × 20 ,,	36/4 to 38/4
,,	20 × 10 ,,	26/-
,,	18¾ × 14 ,,	18/9
C.W.	20 × 14 ,,	15/3 to 15/6
,,	28 × 20 ,,	32/6 to 33/-
,,	20 × 10 ,,	23/- to 23/3
,,	18¾ × 14 ,,	15/6 to 15/9

SWEDISH CHARCOAL IRON & STEEL

	£	s.	d.		£	s.	d.
Pig-iron	£6	0	0	to	£7	0	0
Bars-hammered, basis	£16	0	0	to	£16	10	0
Bars and nail-rods, rolled, basis	£15	15	0	to	£16	0	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£30	0	0	to	£31	0	0
Faggot steel	£18	0	0	to	£23	0	0
Bars and rods dead soft, st'l	£10	0	0	to	£12	0	0

All per English ton, f.o.b. Gothenburg
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

	£ s. d.	
July 4 ..	30 8 9	inc. 1/3
,, 5 ..	30 3 9	dec. 5/-
,, 8 ..	29 13 9	,, 10/-
,, 9 ..	29 18 9	inc. 5/-
,, 10 ..	30 6 3	,, 7/6

Electrolytic Copper

	£ s. d.	
July 4 ..	33 15 0	No change
,, 5 ..	33 0 0	dec. 15/-
,, 8 ..	33 0 0	No change
,, 9 ..	33 10 0	inc. 10/-
,, 10 ..	33 10 0	No change

Standard Tin (cash)

	£ s. d.	
July 4 ..	230 15 0	inc. 10/-
,, 5 ..	230 5 0	dec. 10/-
,, 8 ..	230 15 0	inc. 10/-
,, 9 ..	230 15 0	No change
,, 10 ..	231 0 0	inc. 5/-

Tin (English ingots)

	£ s. d.	
July 4 ..	230 15 0	inc. 10/-
,, 5 ..	230 10 0	dec. 5/-
,, 8 ..	230 15 0	inc. 5/-
,, 9 ..	230 15 0	No change
,, 10 ..	231 0 0	inc. 5/-

Spelter (ordinary)

	£ s. d.	
July 4 ..	13 15 0	dec. 2/6
,, 5 ..	13 12 6	,, 2/6
,, 8 ..	13 15 0	inc. 2/6
,, 9 ..	13 16 3	,, 1/3
,, 10 ..	13 13 9	dec. 2/6

Spelter (Electro, 99.9 per cent.)

	£ s. d.	
July 4 ..	16 7 6	dec. 2/6
,, 5 ..	16 5 0	,, 2/6
,, 8 ..	16 6 3	inc. 1/3
,, 9 ..	16 7 6	,, 1/3
,, 10 ..	16 5 0	dec. 2/6

Zinc Sheets (English)

	£ s. d.	
July 4 ..	22 17 6	dec. 2/6
,, 5 ..	22 12 6	,, 5/-
,, 8 ..	22 13 9	inc. 1/3
,, 9 ..	22 17 6	,, 3/9
,, 10 ..	22 17 6	No change

Lead (English)

	£ s. d.	
July 4 ..	15 15 0	No change
,, 5 ..	15 15 0	,, ,,
,, 8 ..	15 15 0	,, ,,
,, 9 ..	15 15 0	,, ,,
,, 10 ..	16 0 0	inc. 5/-

A COMPARISON OF SCRAP PRICES

Prices of Heavy Steel Scrap (Delivered) in the Principal Districts at the Beginning of Each Month in the Years 1929–1934.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Scotland—													
1929	3 5 6	3 7 6	3 12 6	3 15 0	3 15 0	3 15 0	3 15 6	3 16 0	3 17 6	3 15 0	3 12 6	3 10 6	3 13 1½
1930	3 9 0	3 7 6	3 5 0	3 5 0	3 0 6	2 15 0	2 12 0	2 10 0	2 13 3	2 10 0	2 10 0	2 10 0	2 17 3½
1931	2 7 6	2 7 6	2 5 0	2 5 0	2 0 0	1 17 6	1 17 6	1 17 6	1 17 6	1 15 0	2 0 0	2 2 6	2 1 0½
1932	2 2 6	2 2 6	2 0 0	1 17 6	1 17 6	1 17 6	1 15 0	1 15 0	1 12 6	1 13 0	1 12 6	1 15 0	1 16 9½
1933	1 15 0	1 17 6	1 18 6	1 18 9	1 18 0	1 17 6	1 18 9	2 0 0	2 2 6	2 5 0	2 7 6	2 8 9	2 0 7½
1934	2 8 9	2 14 3	2 13 0	2 13 0	2 12 0	2 10 0	2 10 6	2 10 6	2 11 0	2 10 9	2 10 0	2 10 0	2 11 2
1935	2 10 0	2 10 0	2 10 0	2 10 0	2 10 0	2 10 0	—	—	—	—	—	—	—
North-East Coast—													
1929	3 0 0	3 2 6	3 3 6	3 3 6	3 3 6	3 5 0	3 5 0	3 5 0	3 5 0	3 6 6	3 5 0	3 3 6	3 4 0
1930	3 3 6	3 3 6	3 2 0	3 0 0	2 17 6	2 10 0	2 10 0	2 7 6	2 7 6	2 7 6	2 5 0	2 6 0	2 13 4
1931	2 6 0	2 6 0	2 5 0	2 5 0	2 2 6	2 0 0	1 17 6	1 17 6	1 17 6	1 17 6	1 17 6	2 2 6	2 1 2½
1932	2 0 0	2 0 0	1 15 0	1 15 0	1 15 0	1 15 0	1 15 0	1 15 0	1 15 0	1 12 6	1 15 0	1 17 6	1 15 10
1933	2 0 0	2 0 0	2 5 0	2 0 0	1 15 0	1 17 6	2 2 6	2 2 6	2 3 6	2 5 0	2 7 6	2 7 6	2 2 2
1934	2 10 0	2 16 0	2 10 0	2 7 6	2 7 6	2 10 0	2 9 9	2 10 0	2 10 0	2 10 0	2 11 6	2 11 3	2 10 3½
1935	2 11 6	2 11 9	2 12 0	2 12 0	2 12 6	2 12 6	—	—	—	—	—	—	—
South Wales—													
1929	3 8 6	3 10 6	3 15 0	4 0 0	4 0 0	3 18 0	3 17 6	3 17 6	3 15 0	3 15 0	3 12 6	3 7 6	3 14 9
1930	3 7 6	3 6 0	3 6 0	3 4 0	3 2 6	2 17 6	2 16 0	2 15 0	2 14 9	2 12 6	2 12 6	2 5 0	2 18 3½
1931	2 5 0	2 7 6	2 7 6	2 7 6	2 5 0	2 2 6	2 0 0	2 0 0	1 18 0	2 2 6	2 5 0	2 7 6	2 4 0
1932	2 6 6	2 6 0	2 5 0	2 2 6	2 2 0	1 19 0	1 17 6	1 18 6	1 18 0	1 18 0	1 17 6	1 18 0	2 0 8½
1933	2 0 0	2 1 6	2 4 0	2 3 6	2 3 6	2 3 0	2 5 0	2 5 0	2 8 0	2 10 0	2 10 0	2 10 0	2 5 3½
1934	2 10 0	2 16 3	2 15 9	2 13 9	2 14 3	2 15 0	2 14 3	2 14 3	2 15 0	2 15 6	2 15 6	2 15 6	2 14 7
1935	2 15 6	2 15 6	2 15 6	2 15 6	2 15 6	2 15 6	—	—	—	—	—	—	—

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Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

BATH MOULDER seeks change. New scheme. Repetition methods.—Box 294, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

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THE Council are about to appoint an Assistant Lecturer in Metallurgy (Founding). Salary £300 per annum. Further particulars may be obtained from the undersigned, with whom applications should be lodged by July 31.

W. M. GIBBONS,
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WANTED, an experienced man to take charge of a large cupola plant melting 1,000 tons of cast iron per day. Apply, giving age and experience, to THE STANTON IRONWORKS COMPANY, LIMITED, near Nottingham.

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FULLY EQUIPPED. Iron Castings to 12 cwts., also Non-ferrous Castings. Customers include Water, Gas and Electricity Supply Companies and Municipal Authorities, etc. At present working. Low price for quick sale.—Particulars of HENRY BUTCHER & CO., 63-64, Chancery Lane, London, W.C.2.

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MACHINERY

LADLES IN STOCK.

30-ton Stevenson ladle, £75.
25-ton Stevenson ladle (new), £70.
10-ton Evans ladle (as new), £40.
6-ton Evans ladle (as new), £30.
5-ton Evans ladle (as new), £28.

A. HAMMOND, 14, Australia Road, Slough.

MACHINERY—*Continued*

BRASSFOUNDER wants small Morgan oil-fired furnace about 150 to 200 lbs. capacity; also git cutter, oil-sand mixer, core-making machine and any useful plant for non-ferrous foundry.—Box 308, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

MORGAN Crucible Tilting Furnaces. Two 450-lb. oil-fired "S" type; two 450-lb. coke-fired "S" type; two 600-lb. coke-fired "S" type; and twenty more of various sizes. Send inquiries to A. HAMMOND, 14, Australia Road, Slough. 'Phone 287.

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

SANDBLAST PLANTS

Room Plants, sizes 12 ft. x 12 ft., 12 ft. x 9 ft. and 6 ft. x 6 ft., made up in cast-iron sections.

Barrel Plants, 30 in. dia. x 36 in. long and 30 in. dia. x 18 in. long rotary barrels.

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Most of the above by Tilghman and complete with Air Compressors.

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By Adaptable, Pridmore, Darling & Sellars, etc.; Squeezers by Utard (unused), Samuelson and Britannia, also Farwell Universal Type.

Ladles, Grinding Machines, Exhaust Fans, Blowers, Air Compressors and 500 Electric Motors and Dynamos.

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24"×48" "Shockless" TABOR rollover.
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8'×8'×8' Tilghman room plant with Tilghman compressor and all equipment, practically new plant throughout.

12' × 9' Tilghman sandblast room, built of cast iron plates, complete with 400 cu. ft. Tilghman air compressor and all accessories. FINE PLANT.

T.B. 4 Tilghman sandblast barrel plant, complete. Size of barrel 60" × 40".

T.B. 1 Tilghman sandblast barrel 30"×20".

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ALEX. HAMMOND, *Foundry Machinery Merchant,*
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MACHINERY—*Continued*

FOR SALE. One open-flame non-crucible semi-rotary-type Melting Furnace, complete with No. 2 Keith-Blackman blowing fan, 4 in. dia. outlet and motor, cowl, auxiliary oil tank and oil and feed pipes. Motor suitable for 400 volts A.C., 3-phase, 50 cycles. Offers and inspection invited. CRAVEN BROS. (MANCHESTER), LTD., Vauxhall Works, Reddish, Stockport.

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